AD-A102 033 HYDROLOGIC ENGINEERING CENTER DAVIS CA F/G 13/2

CHATTAHOOCHEE RIVER WATER QUALITY ANALYSIS.(U)

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CHATTAHOOCHEE RIVER WATER QUALITY ANALYSIS

APRIL 1978

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A102 033
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)* CHATTAHOOCHEE RIVER WATER QUALITY ANALYSIS.	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. G. Willey ~~and~~ Dennis Huff	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Corps of Engineers The Hydrologic Engineering Center 609 Second Street, Davis, CA 95616	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE Apr[illegible]978
	13. NUMBER OF PAGES 239
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)* Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Distribution of this publication is unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

River, Water Quality, Computer Application, Impact Analysis.

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

State-of-the-art stream water quality modeling is applied to a practical case showing impact analysis regarding a proposed sewage treatment plant effluent modification and a proposed level of treatment for non-point runoff.

CHATTAHOOCHEE RIVER
WATER QUALITY ANALYSIS

Final Report to the Waterways Experiment Station
and Savannah District

by

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April 1978

PREFACE

This document is a final report being submitted to the Corps of Engineer's Waterways Experiment Station (WES) and Savannah District Office. This report supersedes the draft report of the same title dated December 1975.

Editorial changes to the draft report include results of WES and HEC reviews and an independent review by Dr. Carl W. Chen, Tetra Tech. Other changes include deletion of chapters and appendices which documented the computer program. The program has been recently documented in the 1977 WQRRS users manual.

Chapter VI required significant change due to the development of more comprehensive computer software since 1975. The display of the temporal change of the water quality condition at a specific location is obtained from a recently developed HEC program. The remainder of the results must be considered preliminary as the programs required to manage the data for display in the format shown are presently under development and scheduled for completion by October 1978. While these results are preliminary and some change in the exact value of the results can be anticipated, no significant difference in the general conclusions should be expected.

The general methodology documented in this report is intended to define methods of obtaining or estimating the data required for aquatic ecosystem computer programs, to demonstrate the interface of rainfall-runoff quantity and quality modeling with receiving water modeling, and to demonstrate the evaluation of the impact on river water quality due to planning alternatives regarding modified treatment levels on municipal-industrial effluents and on stormwater runoff.

R.G. Willey

CHATTAHOOCHEE RIVER WATER QUALITY ANALYSIS

Table of Contents

APPENDICES

Table of Contents

I. INTRODUCTION

Background

Since December 1972, the Corps of Engineers, Savannah District, has been conducting a water resources study in metropolitan Atlanta, Georgia. The study is a joint effort of the Corps, Atlanta Regional Commission, Georgia Environmental Protection Division, and U.S. Environmental Protection Agency.

One of the objectives of the Metropolitan Atlanta Water Resources Study is to develop regional alternatives for wastewater treatment and management in the 7-county area. In conjunction with this effort, broad regional alternatives for treatment of point wastewater sources were developed, including various size, number, and location of treatment plants and various treatment levels. In addition, an evaluation was conducted of the magnitude and treatment options of non-point pollution sources, including urban runoff and combined sewer overflows.

During late 1974, the four agencies conducting the Atlanta study recognized the limitations inherent in the steady-state water quality computer models available for evaluating wastewater management strategies. A related question concerned the amount and validity of data available for water quality analysis, including the input data and cost-effectiveness of structural and non-structural management techniques.

Subsequently, during early 1975 the four agencies initiated discussions with the Corps' Waterways Experiment Station (WES) in Vicksburg, Mississippi and the Hydrologic Engineering Center (HEC) in Davis, California regarding assistance in evaluating water quality and computer modeling needs for metropolitan Atlanta.

In January 1975, the Hydrologic Engineering Center was engaged to adapt a state-of-the-art water quality computer model for one of the major rivers in Metropolitan Atlanta and to demonstrate the potential for assessing the impact of selected pollution sources on water quality in a receiving stream. The computer program, "Water Quality for River-Reservoir Systems" (WQRRS) was selected by the four study agencies and was to be adapted by HEC for the 116-mile reach of the Chattahoochee River between Buford Dam and the headwaters of West Point Reservoir. The location map shown in figure I-1 defines the boundaries of the study area.

Scope and Objectives

The general objectives for adapting the WQRRS model to the study area were to demonstrate the capability for interfacing storm water modeling results with selected pollutants from other sources and evaluating their individual impacts on the river water quality condition. The procedure and data requirements for calibrating the model were to be defined in a documented methodology that could be used by personnel of the four study agencies in continuing studies.

The developed methodology uses available data only, since neither time nor funds were authorized for data collection. The quantity and quality of sewage treated effluents were furnished by Georgia's Environmental Protection Division, but the developed methodology includes procedures for estimating quantity and quality of storm water runoff from the entire study area.

The methodology for evaluating the impact on the water quality of the Chattahoochee River due to improved treatment at the existing sewage treatment plants, and due to the collection and treatment of storm water runoff for existing conditions will be demonstrated.

Specific tasks to be accomplished by the study include the following:

1. Modify the Corps' steady flow "Water Quality for River-Reservoir Systems" (WQRRS) model (1) to include the capability for unsteady flow analysis.

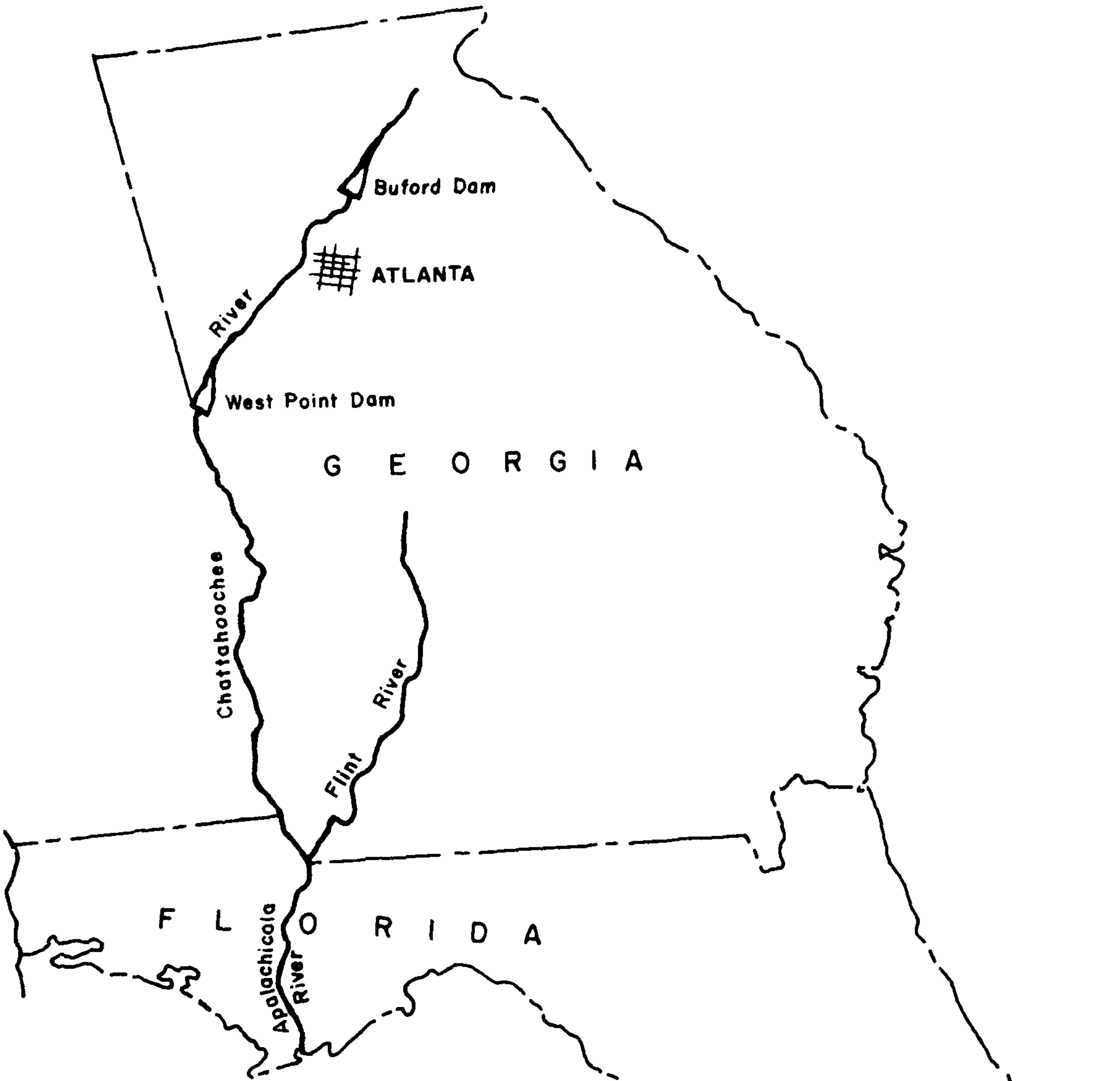


Fig. I-1. Location Map for Study Area

2. Develop a preprocessor to facilitate the preparation of input data for the dynamic WQRRS model.

3. Select a representative study period for analysis. Locate and assemble the necessary meteorological, geometrical (i.e., cross sections), hydrological, and water quality data. Estimate any additional data required. The hydrological and water quality data were to include in-stream data (for calibration) as well as data for all significant loading and withdrawal points.

4. Examine the study area and discuss data requirements with local field personnel.

5. Develop local flows for ungaged tributaries and streamflow routing criteria for the Muskingum routing method.

6. Develop a procedure for estimating the quality of storm water runoff (i.e., determination of non-point source inflow.)

7. Apply the preprocessor and the water quality model to the Chattahoochee River for existing conditions. Calibrate the model using observed and estimated data. Verify the model on observed data that was not used in the calibration process.

8. Apply the model using the sewage treated effluents with improved treatment and the treated storm water runoff.

9. Compare the Chattahoochee River water quality conditions resulting from tasks 7 and 8.

10. Prepare a report documenting the basic concepts and input description for the model and the results of tasks 7-9. Provide a two-day training seminar on the basic concepts of the model, the Chattahoochee River application, and the study results.

Study Team

The study was conducted under the supervision of Mr. R. G. Willey. Major portions of the technical work were performed by Messrs. D. Huff, J. Abbott, A. Onodera, R. Carl and K. Iceman of the Hydrologic Engineering

Center. Roger Nutter prepared the figures for the report. The Hydrologic Engineering Center (HEC) is a research and training center for the Corps of Engineers. One of its main functions is the development and application of comprehensive hydrologic engineering computer programs for all Corps offices. The HEC has been participating in the development and application of the WQRRS model for about six years. This model and several similar versions were developed by Drs. Chen and Orlob. These models have been applied on more than ten major water quality studies. They have been presented for critical review at several major technical conferences and have been continuously updated as new approaches have been advanced. Mr. Willey has been involved full-time in much of this development work during the last six years.

Dr. Carl W. Chen and Mr. Don Smith of Tetra Tech were consultants to the project providing review of the system coefficients used in the model and evaluation of the resulting output. Dr. Ian King of Resource Management Associates modified the steady flow WQRRS model to perform unsteady flow analysis.

The overall management of the study was provided by Mr. Jerry Brown of the Corps' Waterways Experiment Station and William C. Porter and Larry Lyons of the Savannah District. The project was funded jointly by the Corps' Waterways Experiment Station and the Savannah District.

The required data were graciously provided by the U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), Corps of Engineers' Mobile District, Corps of Engineers' Savannah District, Georgia Environmental Protection Division, (EPD), Georgia Game and Fish Department, Atlanta Water Works (AWW), and Georgia Power (GP). The same offices also provided numerous consultations with the study participants by phone and in-person which were extremely important to this project. The value of these local contacts cannot be over-emphasized.

Computer programs used in this study, other than those developed specially for this study, include Flood Hydrograph Package (HEC-1) (2), Water Surface Profiles (HEC-2) (3), Geometric Elements for Cross Section Coordinates (GEDA) (4), Urban Storm Water Runoff (STORM) (5), and several general utility programs all of which were developed at and are available from the HEC.

II. SUMMARY AND CONCLUSIONS

Summary

The Chattahoochee River study was performed for the purposes of establishing and documenting the methodology for interfacing storm water modeling results with selected pollutants from other sources and evaluating their individual impacts on the river water quality condition. The development of the Chattahoochee River data deck for use in the "Water Quality for River-Reservoir Systems" (WQRRS) computer program is the successful conclusion of establishing this methodology. This report is the conclusion of the effort to document the methodology so that local and state government agencies can easily use the model for evaluation of their own study objectives.

The computer program and the associated data deck should be quite useful in numerous anticipated applications. The model and data deck have been designed specifically to minimize the man-power requirements for studying objectives which differ from those in this project. Examples of other potential applications which would require a minimum modification include evaluating the water quality impact on the Chattahoochee River due to the following causes:

(a) Unprecedented release schedules from Buford Dam,

(b) Encouraging rapid growth and the associated urbanization,

(c) Various feasible treatment levals at the sewage treatment plants or for other pollutant sources such as storm water runoff,

(d) Modification of the network of sewage treatment plants into a well designed and operated system, and

(e) Diversions of water into or out of the basin.

Conclusions

The methodology for interfacing a dynamic river water quality model and a watershed runoff-quality model has been developed. Now that this interface has been completed, watershed quantity-quality analysis similar

to the Chattahoochee River study can be performed with far less emphasis on model development.

The developed procedure was applied to the Chattahoochee River using data that were readily available. Stream profiles were simulated for temperature, dissolved oxygen (DO), ammonia (NH_3), nitrate (NO_3), total phosphate (PO_4), pH, total dissolved solids (TDS), and fecal coliform.

Graphs were produced which show observed and simulated results for each parameter, at specific stream locations for the 90 day study period when instream data were available for comparison. The mean error and the standard deviation of the error were tabulated.

The mean error was added to the most critical (i.e., maximum for all parameters except DO) values from the simulated results for each parameter and each river reach, and envelope curves defined as "maximum or minimum normally expected" functions were constructed. Maximum recorded data were plotted for comparison.

The "existing condition" data input was modified first for simulating treatment of storm runoff, then for improved treatment of municipal sewage. Graphs of the modified simulations were compared with the existing condition simulations and the impact of treating either storm water runoff or more advanced treatment of sewage treatment plant effluents was concluded.

Based on the analyses of simulation results, the following conclusions can be made:

1. Diurnal fluctuations of water temperature can often be as large as 7°C due to the large fluctuation of flows and waste heat input. The water temperature below the Georgia Power Plants does not cause the river water temperature to exceed the 32.2°C standard, but it can potentially cause a change in river temperature in excess of the allowable 2.78°C.

2. The DO level from Camp Creek to Franklin is a potential problem, often having DO concentrations below the 5 mg/l standard. Under normal operating procedures, the DO for approximately 3 miles below Buford dam will also be below 5 mg/l.

3. Plant nutrient concentrations are lower than the drinking water standards, however, they are higher than the level necessary to limit algal growth.

4. TDS concentrations and the pH indicate good quality stream water.

5. The coliform level often exceeds the standards for recreational uses and poses the most serious water quality problem. This coliform problem exists from Suwanee Creek to Franklin.

6. No significant impact was apparent when storm water runoff from existing conditions was treated to the ABT-5 level specified in table VI-2.

7. The upgrading of sewage treatment plants to the ABT-5 level cannot improve the water quality sufficiently to meet the state water quality standards, but it will significantly decrease the nutrient load to a downstream impoundment.

8. While approximately 9 man-months were required for the analyses described in this report, alternative objectives requiring minimum data deck modifications could now be analyzed in .5 to 1 man-months. Very few data deck modifications are necessary for most practical study objectives.

9. The cost of computation time on the Lawrence Berkeley Laboratory CDC 7600 for running the present data deck or one that is slightly modified (i.e., different study objective) would be approximately $360.00 for the 116 miles of river of $3.00 per mile of analysis.

III. CHATTAHOOCHEE RIVER SYSTEM

General

The Chattahoochee River watershed begins in the north-central part of Georgia. The mainstem and several of its tributaries flow into a large impoundment called Lake Sidney Lanier (Buford Dam). Below the dam the river travels southwest past Metropolitan Atlanta to the Alabama-Georgia border where it flows into the recently completed West Point impoundment. The inflow location to West Point is near Franklin, Georgia. The study area was located between Buford Dam and Franklin, as shown in figure III-1. A schematic of the study area including all withdrawal and loading points is shown in figures III-2a to III-2d.

Meteorological

The weather data required for the water quality model includes dry and wet bulb air temperature, percent of the sky that is cloud covered, wind speed and barometric pressure. These data were readily available from the Atlanta Airport, National Weather Service Station WBAN #13874. The short-wave solar and long-wave radiation data required for evaluation of water temperature conditions are calculated within the model based on the latitude and longitude of the site location.

The long-term mean monthly and 1974 precipitation patterns at Atlanta are shown in figures III-3 and III-4, respectively. As shown in figure III-3, the precipitation is fairly evenly distributed through the year with the months of August through November being the four lowest precipitation periods. While the 1974 precipitation pattern differs significantly from the mean annual pattern, as shown in figure III-4, the volume of precipitation is only one inch less. Notice the months of August and November 1974 are not included in the lowest four months as in the long-term mean pattern. However, September and October 1974 have the lowest monthly precipitation in 1974 similar to that shown in the long-term mean pattern.

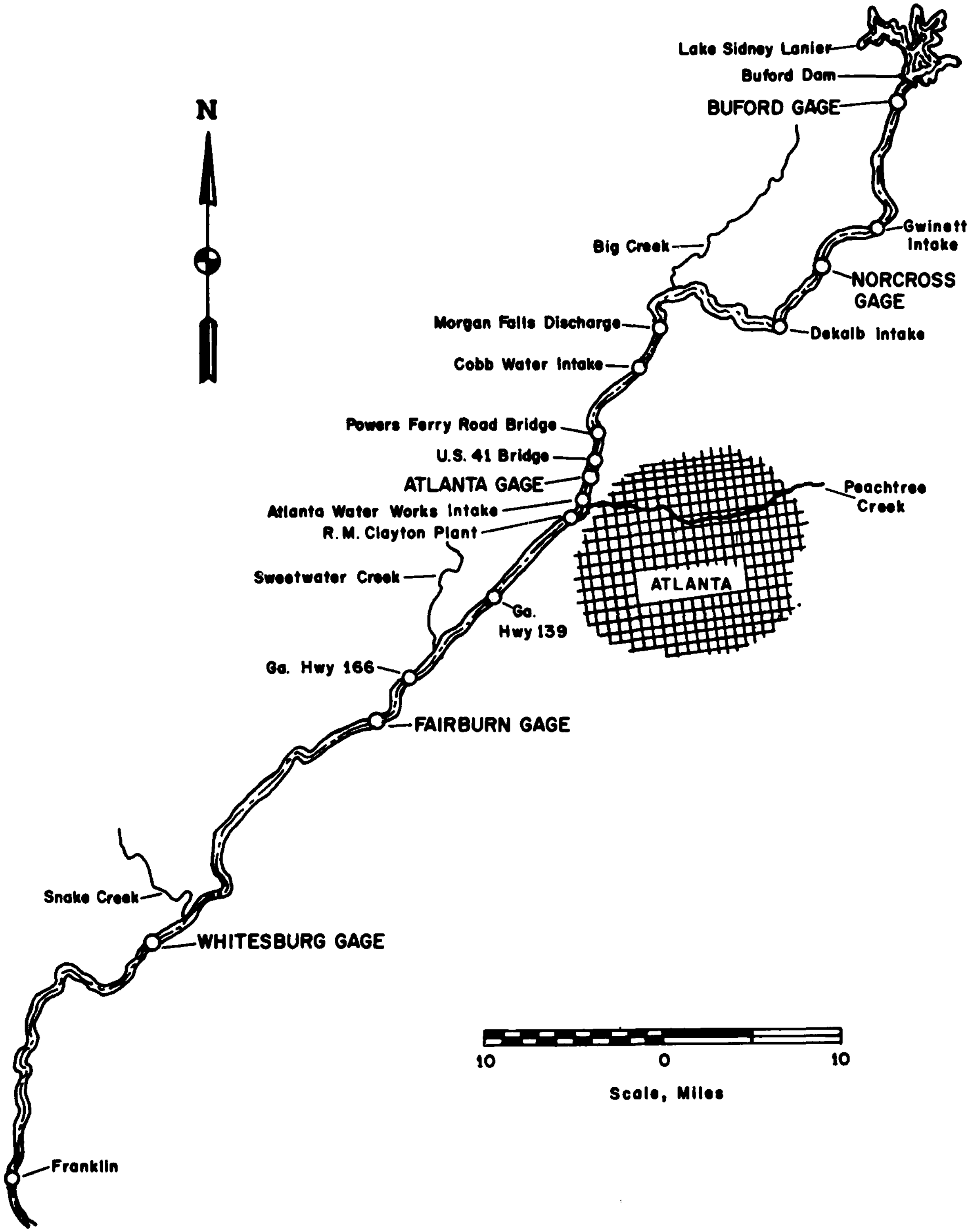


Figure III-1 CHATTAHOOCHEE RIVER FROM BUFORD DAM TO THE FRANKLIN GAGE

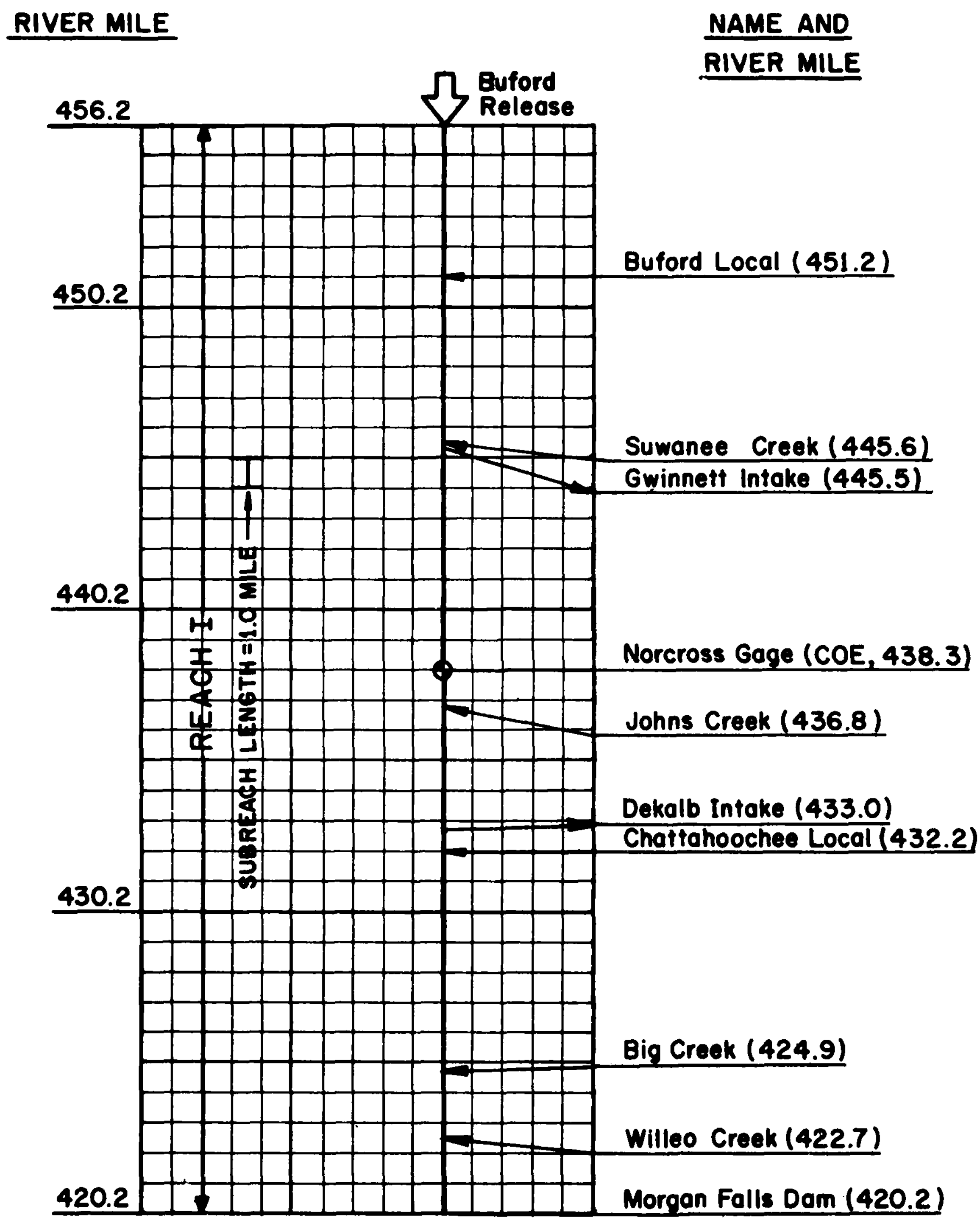
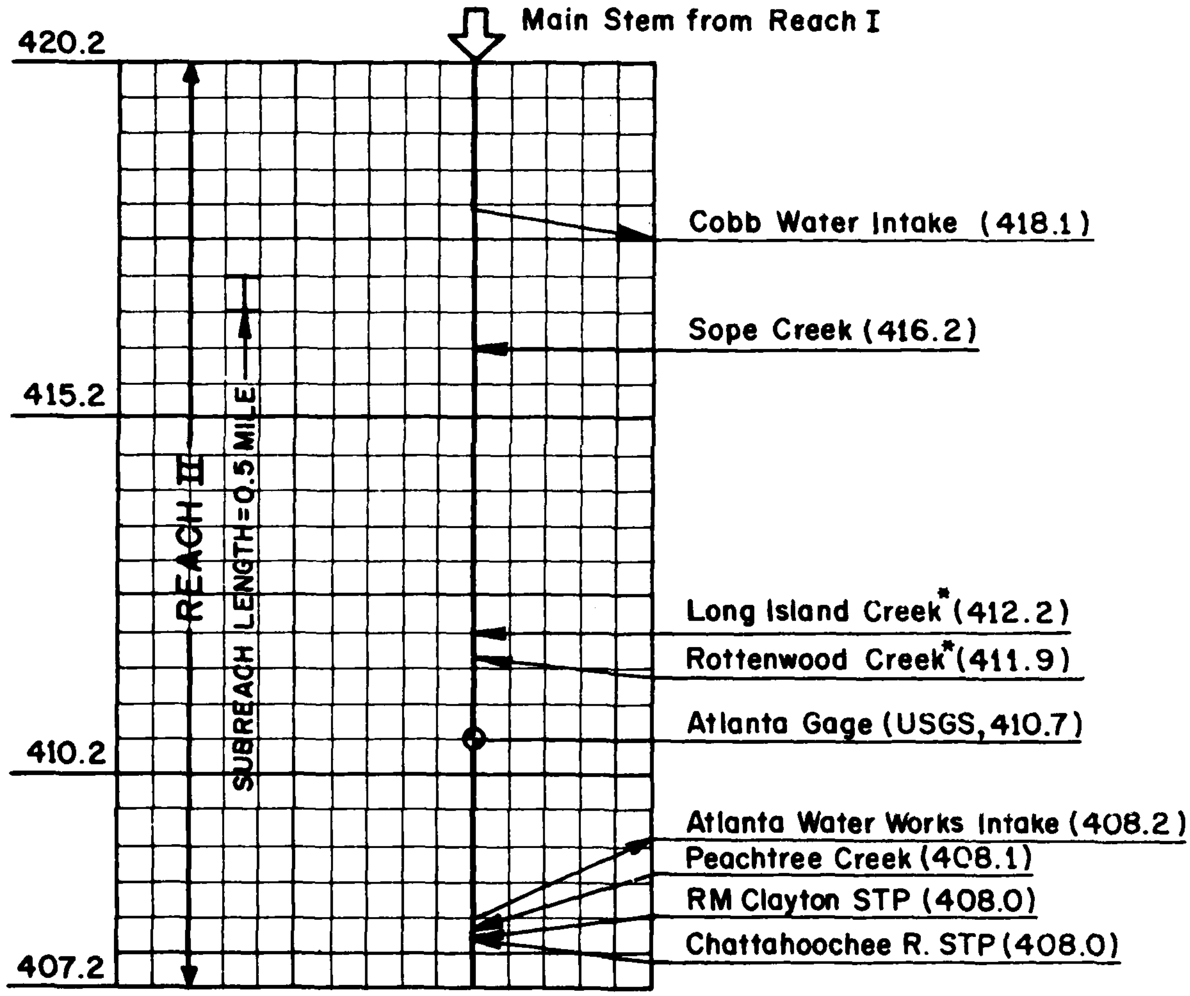
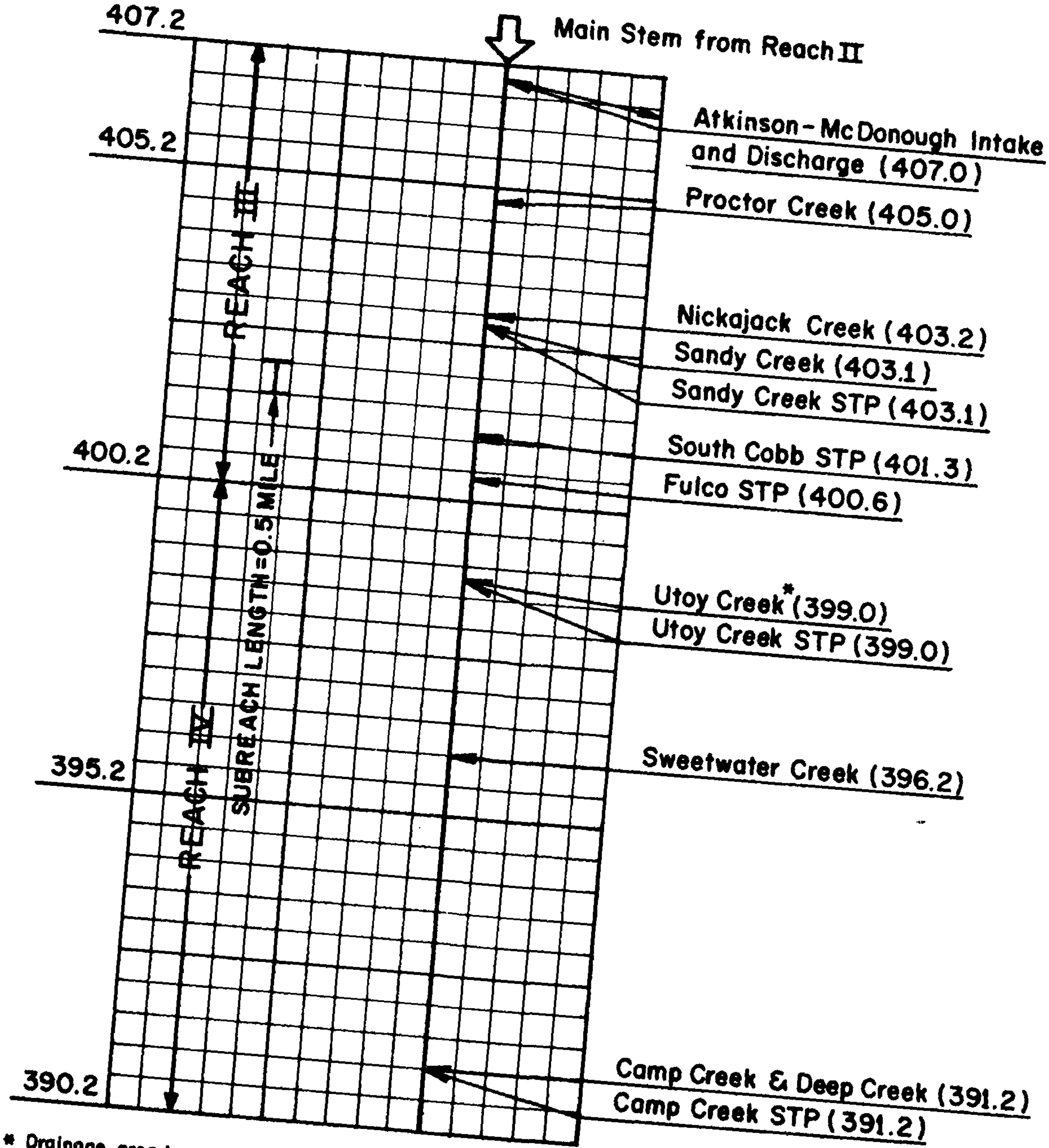


Fig. III-2a. Schematic of Chattahoochee River



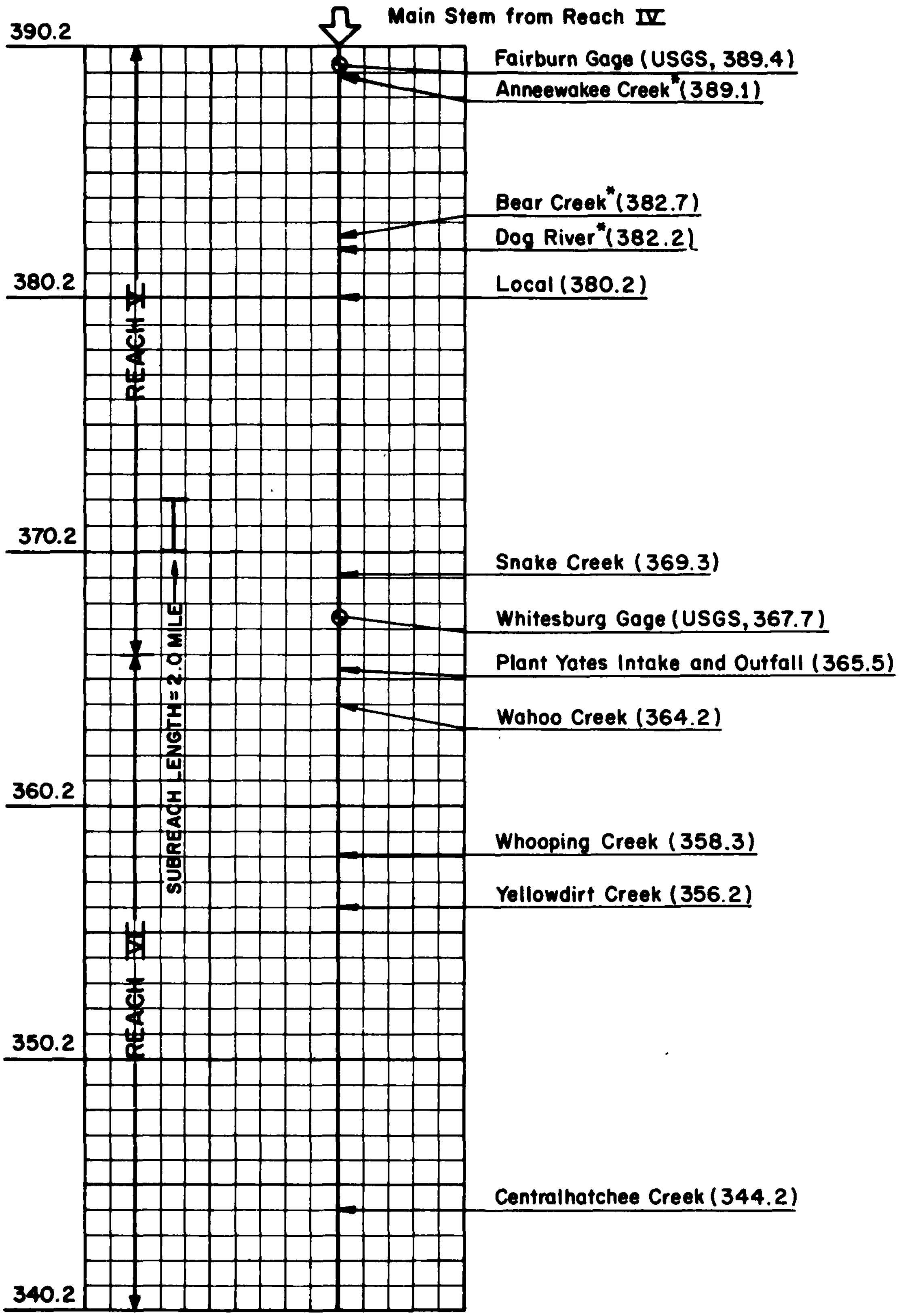
* Drainage area has been increased to account for some local drainage.

Fig. III-2b. Schematic of Chattahoochee River



* Drainage area has been increased to account for some local drainage.

Fig. III-2c. Schematic of Chattahoochee River



* Drainage area has been increased to account for some local drainage.

Fig. III-2d. Schematic of Chattahoochee River

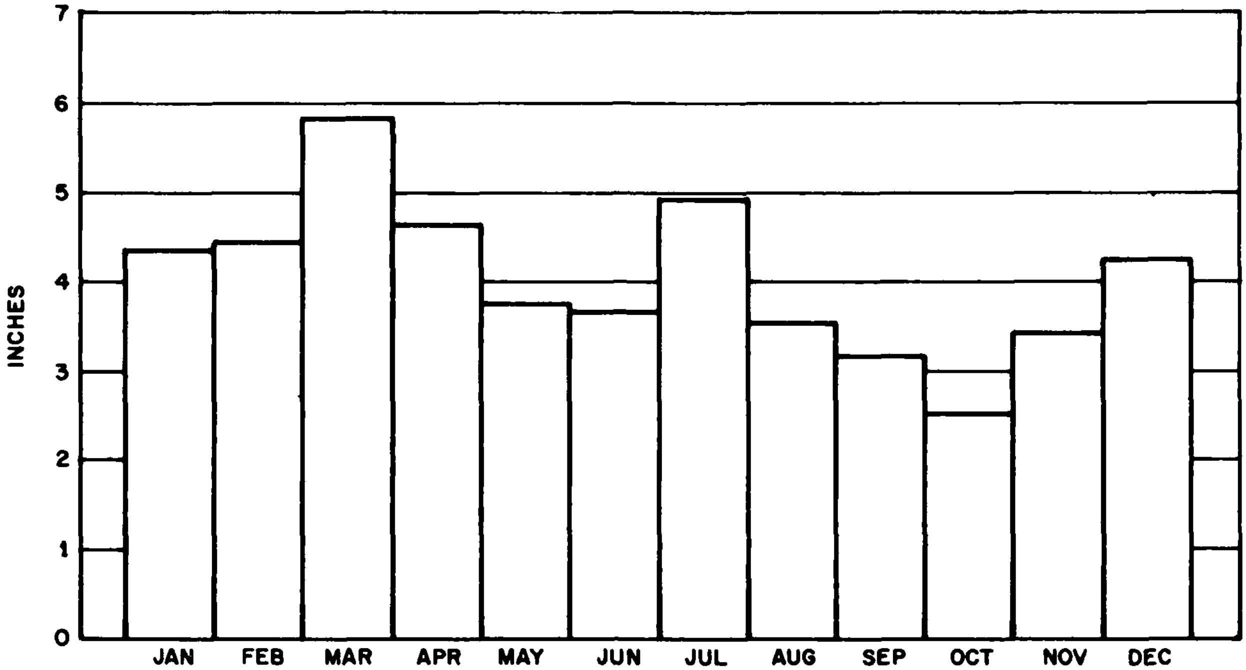


Fig. III-3. Mean Precipitation Pattern at Atlanta (1934-1974)

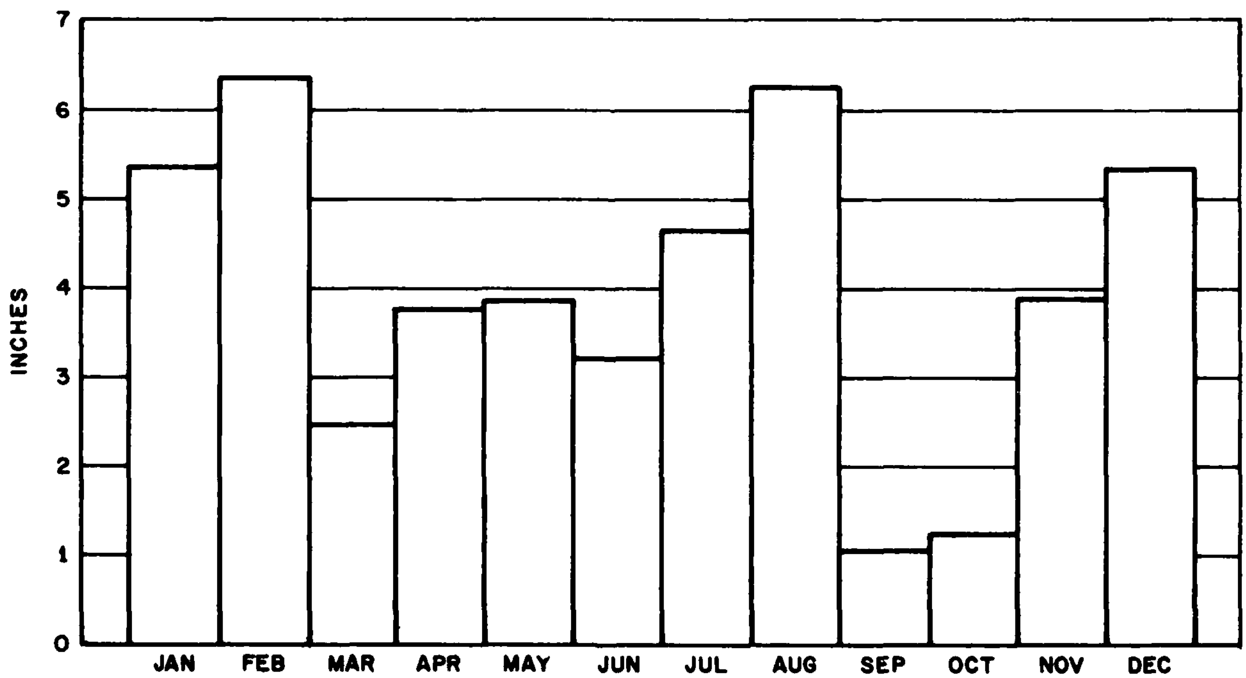


Fig. III-4. 1974 Precipitation at Atlanta

Geometrical

The river channel geometry was well documented with field surveys conducted by the Corps' Mobile District Office. The Corps' survey was performed for a Flood Plain Information Report (6) for the Chattahoochee river channel between Buford Dam and Whitesburg. The U.S. Geological Survey (USGS) has cross sections at Whitesburg and Franklin in the downstream end of the study area.

The numbering of river miles for this study starts with mile 0 being located at the mouth of the Apalachicola River, see figure I-1. The confluence of the Chattahoochee and Flint Rivers is river mile 107.6. The river miles associated with Franklin and Buford Dam (i.e., the study boundaries) are 340.2 and 456.2, respectively.

Hydrological

The Corps' Mobile District Office has excellent records of hourly streamflow data defining their total discharge from Buford Dam into the Chattahoochee River channel. They also maintain a continous stage recorder at Norcross, 15 miles downstream from Buford. The USGS has streamgaging stations located at Paces Ferry Road (Atlanta), Fairburn and Whitesburg. Table III-1 shows the name, location and source of flow data for all inflows and withdrawals. The sources of in-stream flow data are shown in table III-2.

Water Quality

The concentrations of various pollutants and water quality parameters were available for several tributaries, and thermal power plant and municipal sewage treatment plant discharges. The name, location and source of these data are shown in table III-1. Water quality data were available for a greater number of locations than those having flow quantity data but, in general, samples were obtained at irregular intervals (i.e., approximately once or twice per month).

TABLE III-1

LOADING AND WITHDRAWAL DATA INVENTORY

Tributary or Withdrawal	River Mile	Data Sources: Quantity	Data Sources: Quality
Reach I	456.2-420.2		
Buford discharge	456.2	Mobile	Mobile/AWW
Buford Local	451.2		
Suwanee Creek	445.6		AWW
Gwinnett intake	445.5	Gwinnett Co.	
Johns Creek	436.8		
Dekalb intake	433.0	Dekalb Co.	
Chattahoochee local	432.2		
Big Creek	424.9	USGS	AWW
Willeo Creek	422.7		
Reach II	420.2-407.2		
Cobb intake	418.1	Cobb Co.	
Sope Creek	416.2		AWW
Long Island Cr.	412.2		AWW
Rottenwood Cr.	411.9		AWW
Atlanta intake	408.2	AWW	
Peachtree Cr.	408.1	USGS	AWW,USGS
RM Clayton STP	408.0	EPD	EPD
Chattahoochee R. STP (Cobb Co.)	408.0	EPD	EPD

TABLE III-1 (cont'd)

LOADING AND WITHDRAWAL DATA INVENTORY

Tributary or Withdrawal	River Mile	Data Sources Quantity	Quality
Reach III	407.2-400.2		
Atkinson-McDonough Intake and Discharge	407.0	GP	GP
Proctor Creek	405.0		
Nickajack Creek	403.2		
Sandy Creek	403.1		
Sandy Creek STP	403.1	EPD	EPD
So. Cobb STP	401.3	EPD	EPD
Fulco STP	400.6	EPD	EPD
Reach IV	400.2-390.2		
Utoy Creek	399.0		
Utoy Creek STP	399.0	EPD	EPD
Sweetwater Creek	396.2	USGS	USGS
Camp Creek	391.2		
Camp Creek STP	391.2	EPD	EPD
Reach V	390.2-366.2		
Anneewakee Creek	389.1		
Bear Creek	382.7		
Dog River	382.2		USGS/AWW
Local	380.2		
Snake Creek	369.3	USGS	

TABLE III-1 (cont'd)

LOADING AND WITHDRAWAL DATA INVENTORY

Tributary or Withdrawal	River Mile	Data Sources Quantity	Data Sources Quality
Reach VI	366.2-340.2		
Yates intake and discharge	365.5	GP	GP
Wahoo Creek	364.2		
Whooping Creek	358.3		
Yellowdirt Creek	356.2		
Centralhatchee Creek	344.2		

Sources: AWW - Atlanta Water Works: Grab Samples of Temperature, DO, BOD, HN3, NO3-N, PO4, TDS, pH, alkalinity, coliform and others.
EPD - NPDES permits for STP: Mostly BOD, some temperature, DO, NO3-N, pH and others and discharge.
GP - Georgia Power: Thermal plant operating specs, capacity, heat rejection, flow for units. These data were obtained by GP contract with Dr. John Edinger [7].
USGS- Geologic Survey: Grab samples of temperature, DO, BOD, NH3-N, total N, total P, pH, alkalinity, coliform and others. Hourly discharge for study period.
Mobile - Corps' Mobile District: Turbine Q and monitor of Temperature, DO, pH and others.
Gwinnett Co. - Intake withdrawal, mean monthly Q.
Dekalb Co. - Intake withdrawal, mean monthly Q.
Cobb Co. - Intake withdrawal, mean monthly Q.

TABLE III-2. IN-STREAM DATA INVENTORY

Location	River Mile	Data Sources Quantity	Data Sources Quality
Reach I	456.2-420.2		
Below Buford	455.2		GP
Buford Gage	453.4	USGS	
Suwanee Creek	445.6		AWW
Gwinnett Intake	445.5		AWW/EPD
Norcross Gage (State Hwy. 141)	438.3	Mobile	GP
Dekalb Intake	433.0		AWW/EPD
Big Creek (State Hwy. 19)	424.9		AWW/GP
Morgan Falls	420.2	GP (stage)	GP/AWW
Reach II	420.2-407.2		
Cobb Intake (Johnson Ferry Rd.)	418.1		GP/AWW/EPD
Powers Ferry Rd. (Akers Mill Road)	413.8		AWW/GP
U.S. Highway 41	411.1		AWW/GP
Atlanta Gage (Paces Ferry)	410.7	USGS	GP/AWW/EPD
Atlanta Water Works Intake	408.2		AWW/EPD
State Highway 3 (Marietta Blvd.)	408.0		GP

TABLE III-2. IN-STREAM DATA INVENTORY (cont'd)

Location	River Mile	Data Sources Quantity	Data Sources Quality
Reach III	407.2-400.2		
Atkinson-McDonough Plant	407.0		GP
State Highway 280	406.1		GP
U.S. Highway 285	405.1		EPD
State Highway 139 (Gordon Road)	402.0		EPD/GP
Reach IV	400.2-390.2		
State Highway 166	393.1		EPD/GP
Reach V	390.2-366.2		
Fairburn Gage (State Highway 92)	389.4	USGS	EPD/GP
Capps Ferry Road	378.8		EPD/GP
Whitesburg (State Highway 16 & U.S. Highway 27A)	367.7	USGS	EPD/GP
Reach VI	366.2-340.2		
Plant Yates	365.5		GP
Franklin (U.S. Highway 27)	343.5		EPD/GP

Sources: USGS - Geological Survey, Q and grab samples of temp, DO, BOD, NH3-N, total N, total P, pH, alkalinity, coliform and others.

EPD - State Environmental Protection Division, Q and grab samples of temp and DO regularly, and BOD, NH3, etc., irregularly.

GP - Georgia Power, temp and DO. These data were obtained by GP contract with Dr. John Edinger [7].

AWW - Atlanta Water Works, grab samples of temp, BOD, DO, NH3, NO3-N, PO4, TDS, pH, alkalinity, coliform and others.

Mobile - Corps' Mobile District, continuous stage.

In addition to having background level water quality data available for several tributaries, an HEC computer program, STORM, (5) was used to evaluate the water quality concentrations due to storm runoff for all the tributaries shown in table III-1. The results from STORM include concentrations for biochemical oxygen demand (BOD), total inorganic nitrogen, total phosphate, and suspended solids.

In-stream water quality data were also available for the Chattahoochee River at several gage sites from several sources as shown in table III-2. This data is important to the study for purposes of calibrating the model to existing conditions in contrast to the required input data from tributaries, sewage treatment plants and withdrawals.

IV. MODEL FORMULATION

General

A comprehensive ecological simulation model for aquatic environments (ECO model) was developed for the Office of Water Resources Research by Drs. Chen and Orlob in December 1972 (8). That same year the Corps' Hydrologic Engineering Center (HEC) contracted with Dr. Orlob's firm, Water Resources Engineers, to combine their reservoir and river ecologic simulation models into one water resource system model. This new model is capable of analyzing up to 18 different physical, chemical and biological water quality parameters in any river or reservoir or any river-reservoir system. A preprocessor was developed by the HEC for simplifying the preparation of input data. This package of programs is called the "Water Quality for River-Reservoir Systems" (WQRRS) model (1).

The original river routines analyze dynamic water quality conditions but were developed to handle only steady-state hydraulic conditions (i.e., no channel routing). In September 1974, the HEC contracted with Resource Management Associates to add streamflow routing capability to the WQRRS model (9). The model is being developed to include the capability for routing streamflows using either the St. Venant equations, Kinematic Wave, Muskingum, or Modified Puls routing methods. The model can also be used in a steady flow mode with either backwater analysis or a stage-flow relationship specified by input data.

Structure*

The WQRRS model is a modular set of mathematical computer programs developed specifically for the dynamic solution of water quality analysis of river and reservoir systems. The programs making up the total package are designed to interface data and results through magnetic tape, disk files, or punched cards. Three separate but integrable modules exist within the WQRRS model. The stream analysis programs consist

*Portions of this material were excerpted from reference 9.

of a dynamic flow routing module, a dynamic stream water quality module, and a preprocessor program for each module. The reservoir analysis programs include the reservoir water quality module and a preprocessor program.

The system analysis procedure for river basin water quality modeling can be performed with the reservoir results being used as input to the stream module or vice versa. Each module is also fully capable of running in a stand alone mode.

Many of the same subroutine names, variable names, common blocks and computer logic are used throughout the three modules to help the user feel more comfortable when working with the various modules. Figures IV-1, IV-2 and IV-3 show the computational sequence of the reservoir and stream modules. An important feature to note for each of the three modules contained in the system is that the input data for every program is collected, prepared, synchronized and integrated into the correct sequence and format for the respective module via a preprocessor. Since the WQRRS model is described in detail in reference 1, the model will not be described further in this report.

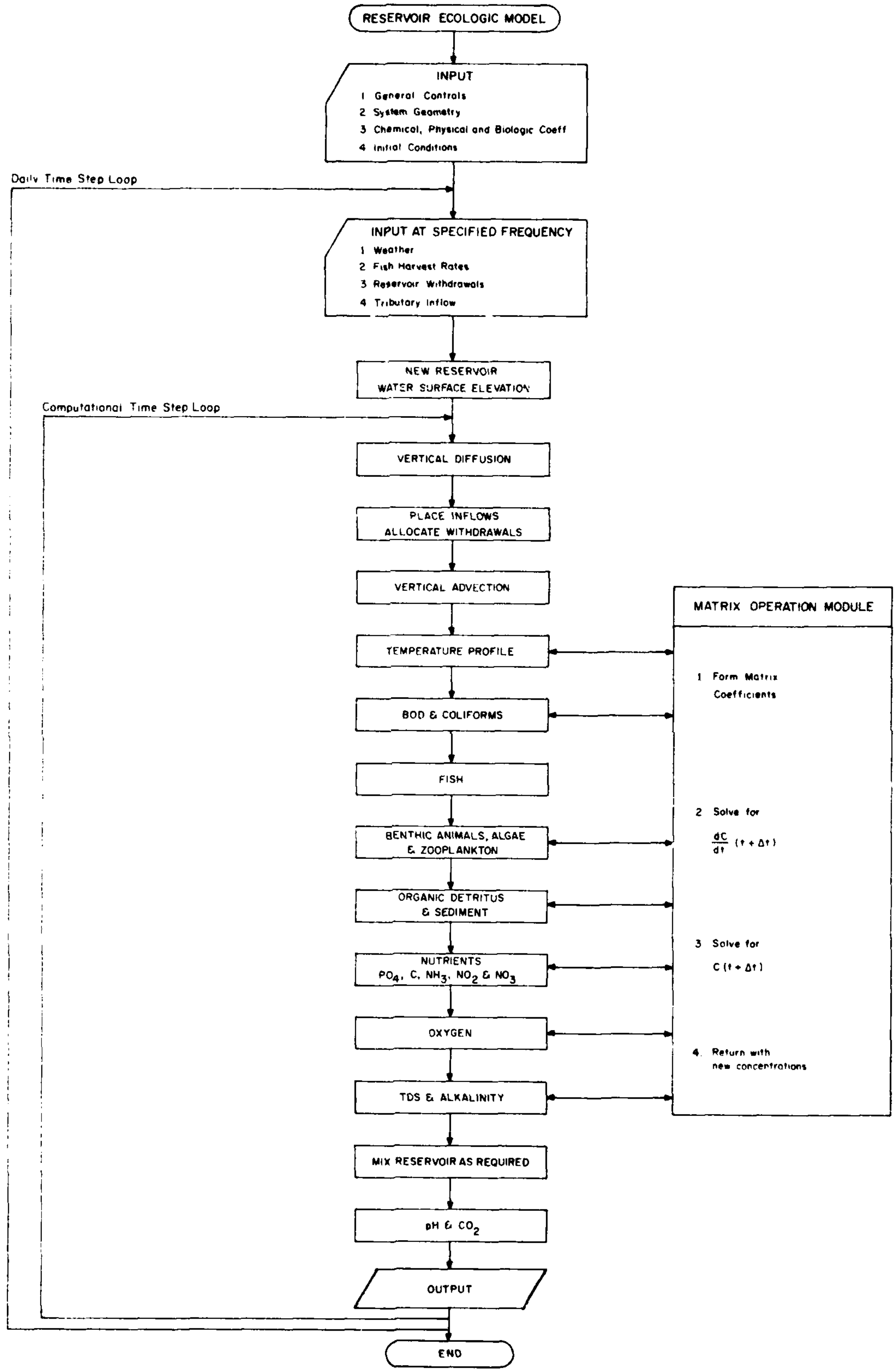


Figure IV-1 COMPUTATIONAL SEQUENCE – RESERVOIR SECTION

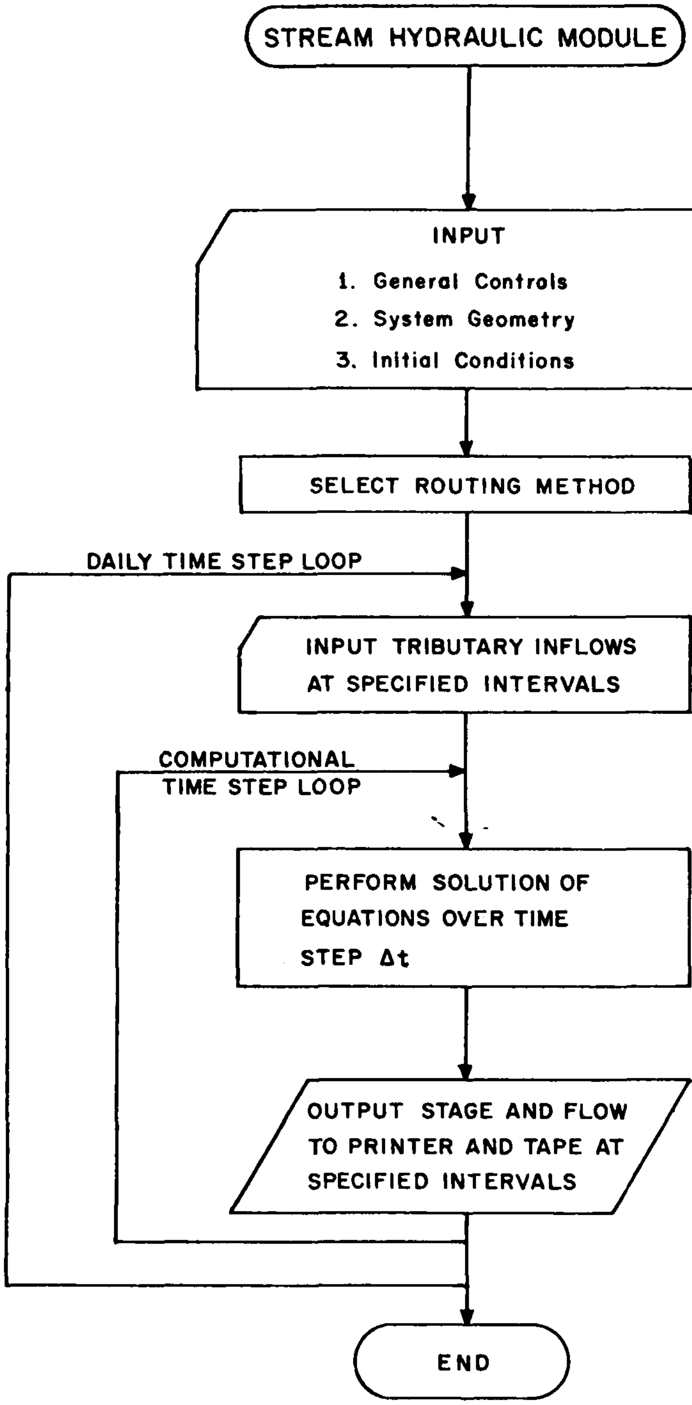


Figure IV -2 COMPUTATION SEQUENCE — STREAM HYDRAULIC MODULE

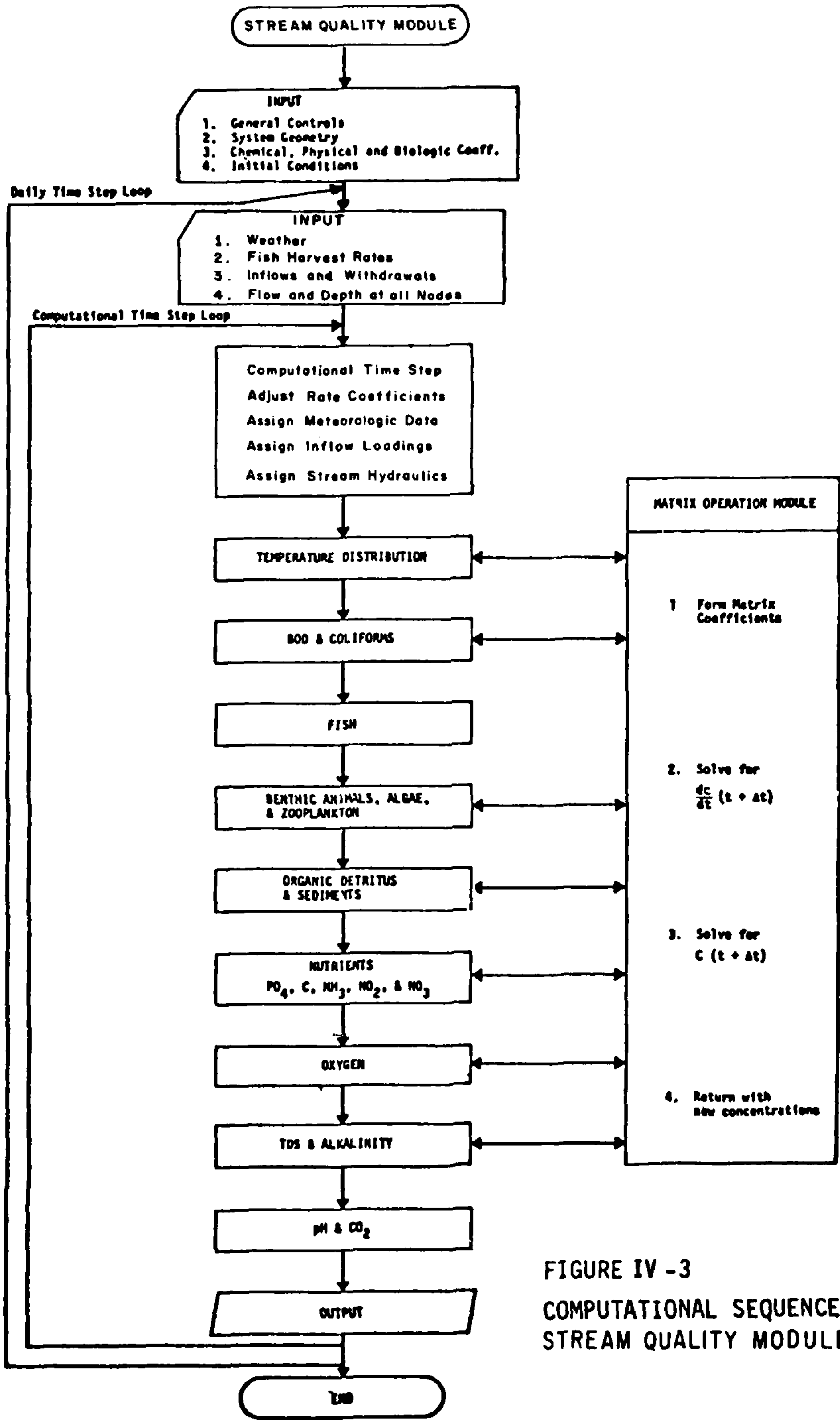


FIGURE IV-3
COMPUTATIONAL SEQUENCE—
STREAM QUALITY MODULE

V. APPLICATION TO CHATTAHOOCHEE RIVER

General

Previous chapters in the report have attempted to familiarize the reader with the physical system of the Chattahoochee River, the general availability of required input data and the historical development and formulation of the dynamic WQRRS model.

The purposes of this chapter are to document the specific methodology applied to the study of this river including unique manipulations of the model and the required input data. It is intended to provide a skeleton procedure to be used on future studies with a similar objective but it is anticipated that changes in the procedure may be required for unique characteristics or objectives of another study.

System Simulation

The WQRRS model has the capability to evaluate water quality conditions in any aerobic river-reservoir system which can be adequately represented by a one dimensional model. This particular study only uses the river routines of the model but interest has been expressed in the eventual additional analysis of either West Point, Buford, or both impoundments. Since these reservoirs have anaerobic hypolimnions, the reservoir routines need expansion to include capability for analysis of anaerobic reservoir conditions. This expansion is being initiated.

Figure V-1 shows the entire river-reservoir system including Lake Sidney Lanier (Buford Dam), West Point Reservoir and a major tributary system as an example for discussion purposes. To demonstrate the steps involved in a general river-reservoir system analysis the following tasks can be outlined:

(1) Simulate Lake Sidney Lanier using the WQRRS reservoir routines and evaluate the quantity and quality of release from Buford Dam.

(2) Simulate the Chattahoochee River from Buford Dam to the Peachtree Creek confluence using the dynamic WQRRS river routines. Input to this

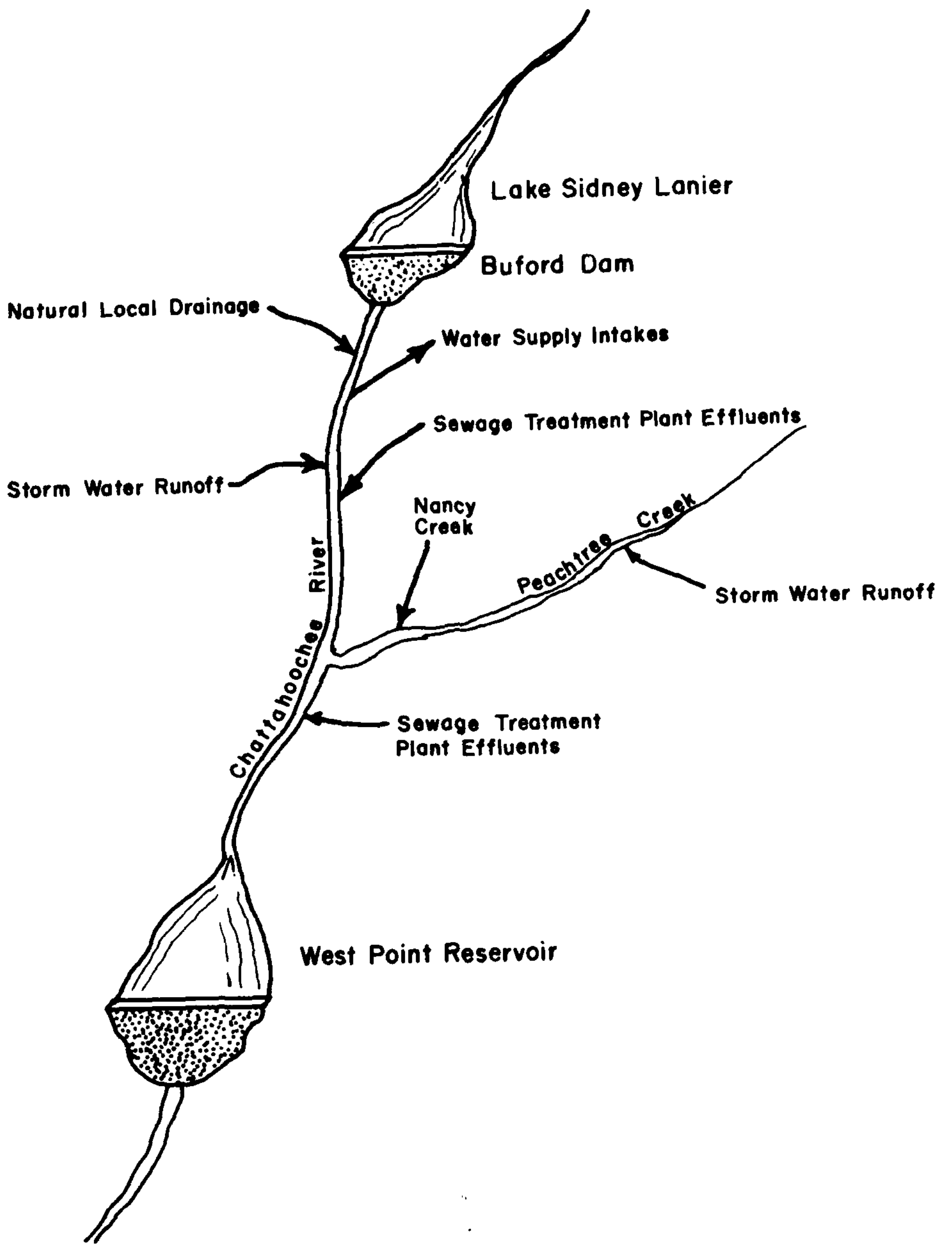


Fig. V-1 Typical River-Reservoir System

simulation includes Buford Dam releases, water supply intake quanities, natural local drainage, storm water runoff, and sewage treatment plant effluents.

(3) Simulate the Peachtree Creek system using the WQRRS river routines. Inputs to this simulation are similar to inputs described in task 2.

(4) The mass balance analyses required at the Chattahoochee-Peachtree confluence are computed automatically as the input loading conditions are specified for the Chattahoochee River analysis.

(5) Simulate from the Chattahoochee-Peachtree confluence to the headwater of West Point using the WQRRS river routines. Inputs to this simulation can include any of the previously described inputs in task 2.

(6) Simulate West Point Reservoir using the WQRRS reservoir routine and the resultant inflow from task 5.

The present study, unlike the preceding example, does not include analysis of either Lake Sidney Lanier or West Point Reservoir or of any tributary systems. It uses known or estimated inputs at Buford Dam and for all tributaries, gaged or ungaged.

Data Sources

The WQRRS model requires data on meterology, inflow quantity and quality, and stream geometry and hydraulics. The task of locating the required input data can be awesome and involve a considerable portion of the entire time allocated for the study. This task can be greatly simplified by beginning with a review of the USGS's Catalog of Information on Water Data and the associated maps (10). While this step can prove to be invaluable in locating most of the sources of available input data for quantity and quality of flow the use of this publication does not eliminate the need to search for additional data. It is often found that the information in this report is not entirely correct and up-to-date. The local sources of data required for this specific analysis have been tabulated in appendix A.

Study Period

The selection of the study period usually follows the task of understanding the local study area and making contacts with sources of local data. Three significant items were learned from the local data source contacts: (1) during the period 29 July to 21 December 1974 the EPD collected in-stream water quality data every 2 days, (2) during July 1974 the R.M. Clayton sewage treatment plant was completed and put on-line, and (3) on 28 October 1974 Buford releases were increased significantly over normal conditions to transfer water to the newly completed West Point impoundment. Because the study objectives required comparison with existing conditions and because good verification data at regular intervals was needed, the study period between 1 August and 27 October 1974 was selected for the existing condition test period.

Meteorological

A magnetic tape of weather data for the Atlanta Airport Weather Station was ordered from the Weather Service office in Asheville, North Carolina. The request included the station name, period of interest, magnetic tape format and tape specification (i.e., density, parity, number of tracks, etc.). An example of this request is included in appendix B.

The tape was ordered for the period from January 1965 through December 1974 because there is a fix cost for up to 10 years of data at one station. Having ordered the last 10 years of records allows for potential future studies of other periods of record.

The tape format ordered is called "Card Deck 144" (CD-144). This format includes all the required weather parameters and is one of the least expensive methods of transferring the data from the Weather Service. The cost associated with either of these formats is usually $70 per 10 station-years. A manual describing the tape format for CD-144 is included in appendix B.

This cost estimate only applies to orders for data that have already been processed. If a recent month is requested, the cost is usually $25 per station-month.

The HEC has a utility program which transfers the weather data from the CD-144 format to the format required by the WQRRS model. This utility program makes the weather data preparation the easiest and least expensive of all tasks to perform.

The input weather data update interval used for this analysis was every three hours every day. This is the shortest update interval available. It provides for dynamic variations in meteorological conditions during each day of the study period.

The "Local Climatological Data" is shown in appendix B.

Geometrical

The Mobile District of the Corps of Engineers used the HEC-2, Water Surface Profiles, computer program (3) for analysis of the backwater profile in the Chattahoochee River from Buford Dam to Whitesburg for their flood plain information study (6). Several years ago, the District obtained, by field survey, the input cross section data required by HEC-2 and coded the data for use in the model.

At HEC's request, the District sent punched cards containing data on several hundred cross sections including numerous bridge sections. The cross section data was in HEC-2 format (i.e., tables of station-elevation coordinate pairs defining each section). The sections described by the data were located at irregular intervals along the channel (generally at transitions and controls). Instead of using cross section data, the WQRRS model requires tables of geometric and hydraulic elements.

The cross section data were transformed to the required WQRRS input data by a modified version of the GEDA, Geometrical Elements for Cross Section Coordinates, computer program (4), which is capable of developing tables of hydraulic properties at intervals of interest using the HEC-2 formatted cross section data. The GEDA modifications used for this project consisted of logic to obtain the best "representative" hydraulic properties based on weighting the hydraulic properties of the input sections by distances between those sections. HEC-2 bridge sections were first removed from the input deck be-

cause they were considered unrepresentative of the stream geometry.

Cross section data downstream of Whitesburg were non-existent except for a section at Franklin. The Whitesburg and Franklin sections were input to GEDA and "representative" sections were interpolated for developing the hydraulic properties of each subreach.

The weighting computation for the "representative" sections can be demonstrated best by use of an example. Figure V-2 shows an example segment of the Chattahoochee River including locations of measured cross section data, 1-mile subreach lengths and example calculation zones for the purposes of discussion.

The calculation zone at mile 3 requires computations quite typical of the majority of the subreaches between Buford Dam and Whitesburg. In this zone, the upstream end (i.e., point a) has a measured cross section exactly at the zone boundary but at the downstream end (i.e., point d) a section is interpolated based on the two closest cross sections (i.e., point c and e) weighted according to their distance from the boundary.

The next step is to calculate the hydraulic properties at a section at mile 3 by the following equation:

$$\begin{aligned} X_3 = {} & 1/2(\text{distance a-b})\ X_a + (1/2(\text{distance a-b}) \\ & + 1/2(\text{distance b-c}))\ X_b + (1/2(\text{distance b-c}) \\ & + 1/2(\text{distance c-d}))\ X_c + 1/2(\text{distance c-d})\ X_d \end{aligned} \qquad \text{V-1}$$

where: X_i = cross section properties at point i.

The WQRRS model will interpolate between this section at mile 3 and a similarly calculated section at mile 4 for the hydraulic properties for each subreach or at each node.

The calculation zone for mile 0 differs from that at mile 3 because only cross sections in the downstream direction are relevant to the calculation. Calculations for a section at mile 7 are obviously similarly affected.

The calculation zone for mile 6 is similar to the actual reach from Whitesburg to Franklin. When the only available (known or interpolated) cross sections in a computation zone are located at the boundaries, the

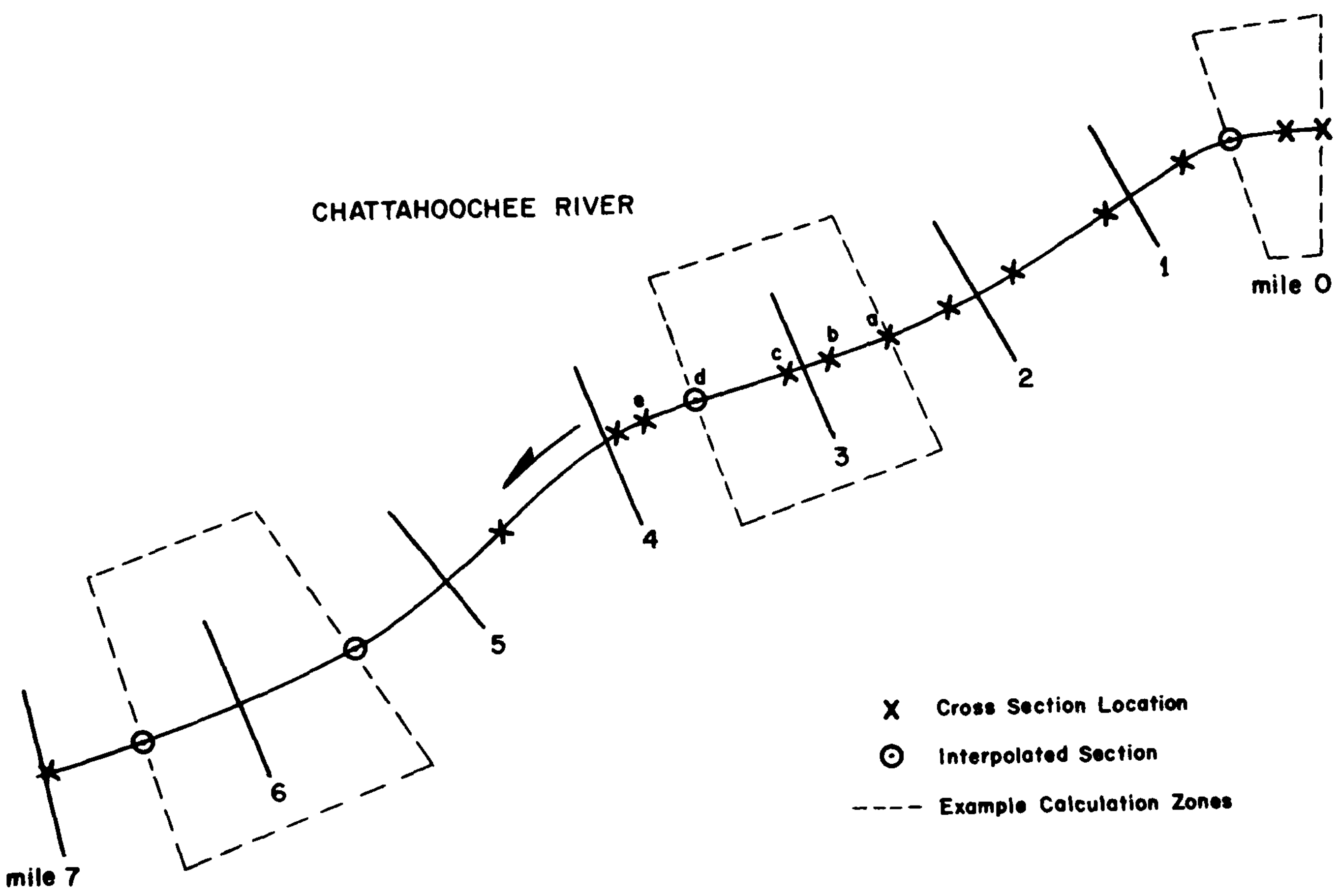


Fig. V-2. Example Cross Section Manipulation

weighting computation (i.e., equation V-1) is not necessary and the nodal sections are obtained by linear interpolation.

The development of the necessary geometrical data for the WQRRS model was a minor task requiring approximately 1 man-week once the GEDA program modifications were completed. The short amount of time required to prepare this input data was due to the modified GEDA program and the Mobile District supplying the Chattachoochee River cross sections.

Hydrology and Hydraulics

Development of the hydrologic input data was a major task. As shown in table III-1, many of the major tributaries along the Chattahoochee River are ungaged. These flows had to be estimated as well as flows from all local drainage.

Analysis of the hydrology began by obtaining the study period flow records at Atlanta, Fairburn and Whitesburg, the stage records and rating curve for Norcross, the discharge records at Buford Dam, and the power generation and operating head records at Morgan Falls.

The Norcross stages were converted to flow using the Corps' stage-discharge rating curve. Morgan Falls discharge through the turbines can be estimated from the records on power generation with the following equation:

$$Q = P/(CeHt) \qquad \text{V-2}$$

where

Q = turbine discharge in cfs

P = power generated in kilowatt hours

C = conversion constant = .08464

e = plant efficiency = .72

H = effective head = pool elevation - tailwater elevation - estimated head loss of four feet

t = computation interval = 1 hour

To determine the flow for the ungaged tributaries, a flow balance was made by subtracting all flows of gaged tributaries and the next most upstream gaged station in the mainstem from that of a downstream mainstem gage. The following equation is used to proportion the unbalanced flow to each ungaged tributary in accordance with the relative magnitude of its drainage area.

$$V_i = V_T(DA_i/DA_T) \qquad \text{V-3}$$

where

V_i = Volume of flow for ungaged tributary i

V_T = Volume unaccounted for by gaged data

DA_i = Drainage area of the ungaged tributary i

DA_T = Drainage area unaccounted for between 2 mainstem gaging stations.

After calculating V_i for each ungaged tributary between 2 mainstem gages, any remaining volume was defined as local drainage.

For a dynamic flow routing, an inflow hydrograph is needed in lieu of the volume of flow. The study developed pattern hydrographs either from a nearby gaged tributary or by combining hydrographs from several gaged tributaries. These patterns were then used to index the shape of the hydrographs developed for the nearby ungaged tributaries. Five pattern hydrographs were developed using the USGS streamflow records for four stations as shown in table V-1.

TABLE V-1. PATTERN HYDROGRAPH DEVELOPMENT

Pattern	USGS Station #	USGS Station Name	Weighting Factor
A	5700	Big Cr. nr. Alpharetta	1.0
B	6300	Peachtree Cr. at Atlanta	1.0
C	6300	Peachtree Cr. at Atlanta	.33
	7000	Sweetwater Cr. nr. Austell	.66
D	7000	Sweetwater Cr. nr. Austell	.33
	7500	Snake Cr. nr. Whitesburg	.66
E	7500	Snake Cr. nr. Whitesburg	1.0

Table V-1 also shows the weight applied to each station's hydrograph ordin tes to calculate the pattern ordinates. The volume from each ungaged tributary or local drainage was then distributed in time according to the adopted pattern hydrograph listed in table V-2.

TABLE V-2. PATTERN HYDROGRAPH APPLICATION

Tributary	Pattern Used
Buford Local	A
Suwanee Cr.	A
Johns Cr.	A
Chattahoochee Local	A
Willeo Creek	A
Sope Creek	B
Long Island Cr.	B
Rottenwood Cr.	B
Proctor Cr.	C
Nickajack Cr.	C
Sandy Cr.	C
Utoy Cr.	C
Camp Cr.	C
Anneewakee Cr.	D
Bear Cr.	D
Dog Cr.	D
Local	D
Wahoo Cr.	E
Whooping Cr.	E
Yellowdirt Cr.	E
Centralhatchee Cr.	E

Once the ungaged tributaries and local drainage flow rates had been estimated, HEC-1, Flood Hydrograph Package, computer program (2) was applied to develop optimized streamflow routing criteria (i.e., K and x) for the Muskingum method. The optimized values were developed to force

reproduction of a hydrograph at a downstream gage with a known upstream inflow and known or estimated tributary and local inflows.

The optimized values of K and x between gages still had to be interpolated to route between each water quality control point (i.e., every inflow or withdrawal). The optimized x value (i.e., attenuation) was held constant between each pair of mainstem stream gages and the optimized K (i.e., travel time in hours) value was interpolated based on length of for instantaneous translation over a short channel length, then an x of .5 must be used to avoid any attenuation of the peak. The derived routing criteria is shown in table V-3.

The development of the hydrology and hydraulics for this project required approximately 2.5 man-months of effort. This task should be considered to be one of the most important and time consuming tasks during the study.

Water Quality

General

The initial water quality profile for each reach of the Chattahoochee River was assumed to have the same magnitude for each parameter (except algae) as the 1 August inflow at the upstream end of the reach (e.g., reach I profile was obtained from 1 August Buford discharge quality). This commonly used assumption is quite satisfactory for this study since the initial conditions established in this manner are associated with water which is transported out of the study area in six days or less.

The algae profile was based on observed chlorophyll A data collected by Water Resources Engineers (11). The WRE data between Buford Dam and Franklin are shown in figure V-3.

The only initial profile parameters which cannot be identified by the 1 August inflow concentration are the fish, sediment and benthic animals since these parameters are not transported in the inflow.

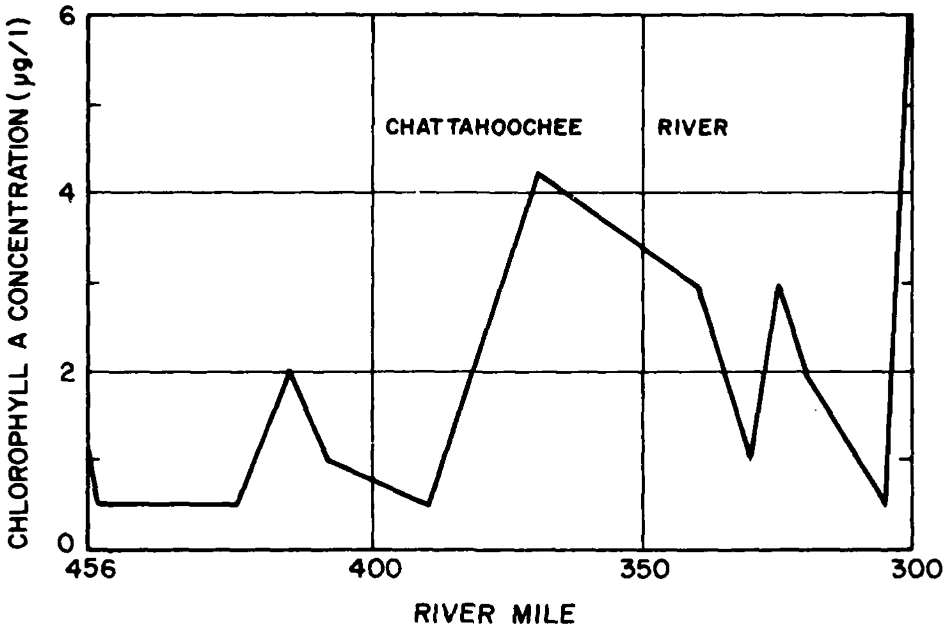


Fig. V-3. Observed Chlorophyll A Stream Profile

TABLE V-3

ROUTING COEFFICIENTS

REACH I

From River Mile	To River Mile	Incremental Miles	No. of Steps	K (hrs)	x
456.2	451.2	5.0	2	.94	.01
451.2	445.6	5.6	2	1.00	.01
445.6	445.5	.1	1	0	.50
445.5	438.3	7.2	2	1.50	.01
438.3	436.8	1.5	1	0	.50
436.8	433.0	3.8	2	.93	.01
433.0	432.2	.8	1	0	.50
432.2	424.9	7.3	2	1.40	.01
424.9	422.7	2.2	1	.80	.01
422.7	420.2	2.5	1	.90	.01

REACH II

From River Mile	To River Mile	Incremental Miles	No. of Steps	K (hrs)	x
420.2	418.1	2.1	1	.5	.04
418.1	416.2	1.9	1	.5	.04
416.2	412.2	4.0	2	.5	.04
412.2	411.9	.3	1	0	.50
411.9	410.7	1.2	1	.5	.04
410.7	408.2	2.5	1	1.2	.05
408.2	408.1	.1	1	0	.50
408.1	408.0	.1	1	0	.50
408.0	407.2	.8	1	0	.50

TABLE V-3 (cont'd)

ROUTING COEFFICIENTS

REACH III

From River Mile	To River Mile	Incremental Miles	No. of Steps	K (hrs)	x
407.2	407.0	.2	1	0	.50
407.0	405.0	2.0	1	1.30	.05
405.0	403.2	1.8	1	.83	.05
403.2	403.1	.1	1	0	.50
403.1	401.3	1.8	1	1.10	.05
401.3	400.6	.7	1	0	.50
400.6	400.2	.4	1	0	.50

REACH IV

From River Mile	To River Mile	Incremental Miles	No. of Steps	K (hrs)	x
400.2	399.0	1.2	1	.70	.05
399.0	396.2	2.8	1	1.20	.05
396.2	391.2	5.0	2	1.10	.05
391.2	390.2	1.0	1	.78	.05

TABLE V-3 (cont'd)

ROUTING COEFFICIENTS

REACH V

From River Mile	To River Mile	Incremental Miles	No. of Steps	K (hrs)	x
390.2	389.4	.8	1	0	.50
389.4	389.1	.3	1	0	.50
389.1	382.7	6.4	3	.91	.07
382.7	383.2	.5	1	0	.50
382.2	380.2	2.0	1	1.00	.07
380.2	369.3	10.9	5	.89	.07
369.3	367.7	1.6	1	.65	.07
367.7	366.2	1.5	1	.73	.07

REACH VI

From River Mile	To River Mile	Incremental Miles	No. of Steps	K (hrs)	x
366.2	365.5	.7	1	0	.50
365.5	364.2	1.3	1	.69	.07
364.2	358.3	5.9	3	.80	.07
358.3	356.2	2.1	1	.85	.07
356.2	344.2	12.0	6	.81	.07
344.2	340.2	4.0	2	.81	.07

Due to the lack of overall data on fish, benthic animals, zooplankton, and algae, the lack of expected changes in their concentrations during a short period of computation, and the concern of many biologists of the ability to accurately predict changes in concentrations of these biota, it was decided that for the purposes of this study their concentrations would be held constant. To estimate their respective concentrations, a field inspection trip was made. Based on the observations in the field and consultation with field biologists, a set of parameter estimates were made. A report by Dr. Carl W. Chen establishing these values is shown in appendix C.

It was estimated that the sediment for reaches I and II should be 10 gm/sq. meter between Buford Dam and Morgan Falls backwater and 150-200 gm/sq. meter in Morgan Falls impoundment. Sediment in reaches III-VI should be 20 gm/sq. meter.

The benthic animals should range between 200-1000 mg/sq. meter for all reaches. The fish standing crop should be about 1.41 kg/km for cold water fish, .06 kg/km for warm water fish and .08 kg/km for benthos feeder fish above the location of the first sewage treatment plant outfall. Below the input of sewage treated effluents the cold, warm, and benthos feeder fish biomass should be .03, .28 and .28 kg/km respectively.

Input requirements for the fish harvest, the algae and zooplankton concentration in tributaries and several biological system coefficients were not needed in this study.

Base Flow

The water quality data for each load point have been tabulated in appendix D. These data are average values for the study period based on measurements at irregular intervals by agencies documented in table III-1. They were used as input to the model to described a base loading condition. The temperature of the baseflow for ungaged tributaries was assumed to be equal to the mean daily air temperature minus 3°F. This assumption is based on the graphical relationship shown in figure V-4.

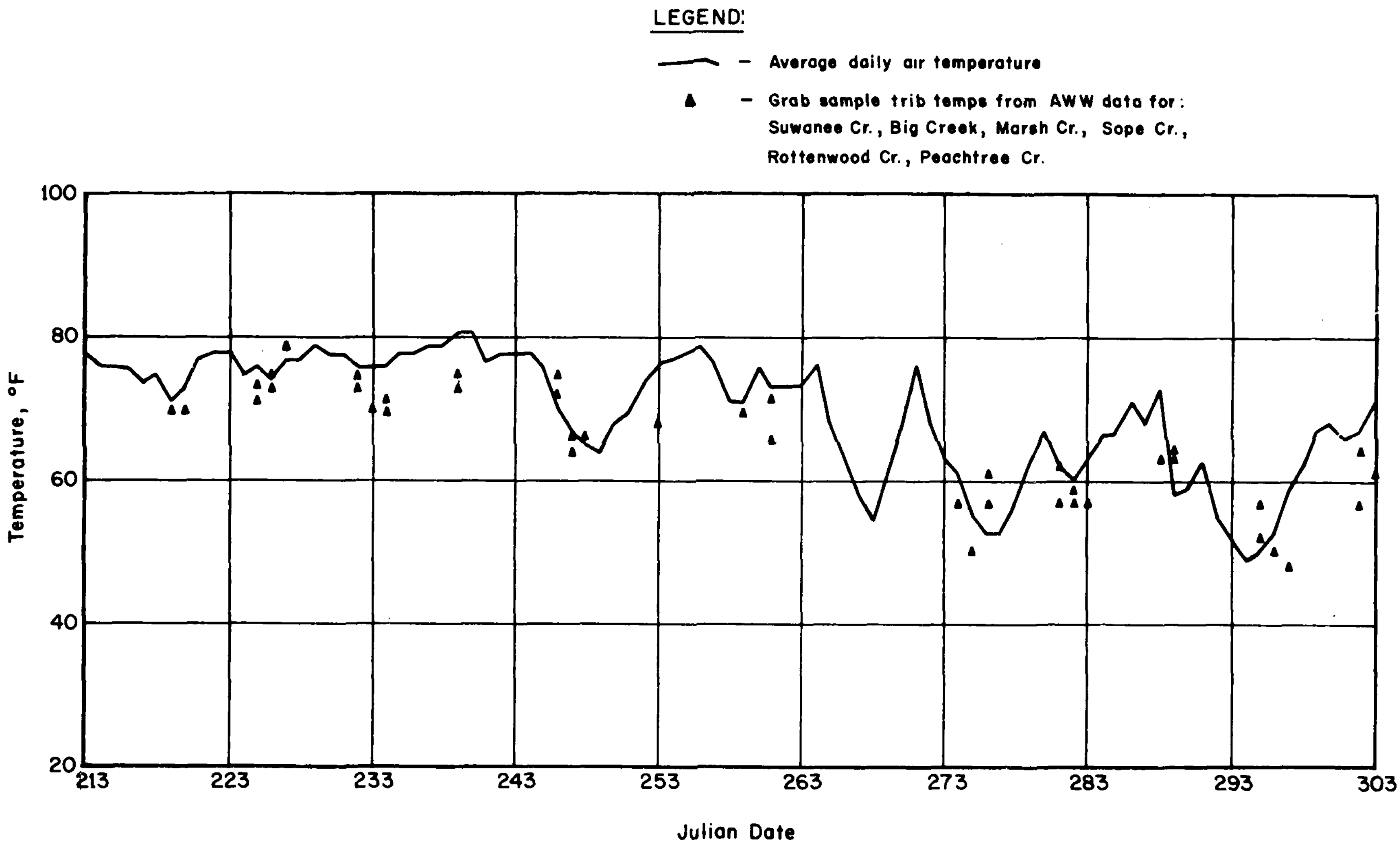


Figure V-4. AIR-WATER TEMPERATURE RELATIONSHIP

Storm

The base flow quality for tributaries was modified to include the quality of storm water runoff by using analytical results from the computer program, Urban Storm Water Runoff, STORM (5).*

The output from STORM included concentrations of suspended solids (SS), biochemical oxygen demand (BOD), total inorganic nitrogen (N) and total phosphate (PO4) for direct runoff events (i.e., not including base flow). The output for BOD and PO4 were multiplied by direct runoff and then used as mass emissions (i.e., loads or flow times concentration) for combining directly with the base flow mass emissions to calculate concentrations for the total discharge.

The actual percentage of N that is NH_3 in urban runoff samples collected at various sites in the United States is shown in table V-4 to have a range from 19 percent to 62 percent. Because of this wide range and the variability of the NH3/N ratio from one storm to the next, a value to 50 percent or .5 was used to adjust the STORM output for N to obtain concentrations for ammonia-nitrogen (NH3) and nitrate-nitrogen (NO3).

The STORM output for SS was multiplied by 30 to obtain fecal coliform during storm events. Similarly SS was multiplied by .25 to obtain detritus (volatile solids). Both of these factors were selected based on the average value of the data shown in table V-4.

The temperature of storm water runoff was assumed to equal the hourly air temperature during the storm.

The direct runoff concentrations for NH3, NO3, fecal coliform, detritus and the water temperature were then mixed with the base flow concentrations using the mass balance concepts explained for the BOD and PO4 calculations.

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* Details involving the calibration of STORM and analysis of storm runoff from the study area are contained in appendix E.

TABLE V-4. URBAN STORM RUNOFF*

Location	Dates	NH_3/N	Coliform/SS	VS/SS
Cincinnati, OH	1962-63	.60	52	.25
Castro Valley,CA	11/11/71 4/5/72	.19-.62	-	-
Oakland, CA	-	-	19	.27
Coshocton, OH	-	-	27	-
Lawrence, KY	-	-	-	.25
Atlanta, GA	1974			
Montreal Rd.		.19	51	-
Plantation Ln.		.51	7	-
Drew Valley		.26	15	-
Parkside Circle		.54	16	-

Legend:

NH_3 = ammonia-nitrogen in mg/l.

N = total dissolved inorganic nitrogen in mg/l.

Coliform = fecal coliform in colonies/100 ml.

SS = suspended solids in mg/l.

VS = volatile solids in mg/l.

* Calculated from references 12 and 13.

All other parameters used in the WQRRS model were assumed equal to their respective base flow concentrations.

Withdrawals

The average monthly demand for municipal and industrial water supply, according to data sources shown in table III-1, is shown in appendix D. It is always assumed that the stream is laterally well mixed and that the water withdrawn contains the same dissolved constituents as the river water.

Sewage treatment Plants (STP)

Sewage treatment plant discharge and quality data for those plants having outfalls located directly on the Chattahoochee River were obtained from the EPA/EPD permit program. The average monthly values are shown in appendix D.

All the STP's shown in figure III-2 discharge directly into the Chattahoochee River. A summary of the plant's characteristics are shown in table V-5. Those STP's discharging into the tributaries were considered to be tributary flow and no separation was attempted.

Combined Sewer Overflows (CSO)

No attempt was made to specifically distinguish CSO's. Their contribution during dry weather is considered in the STP discharge analysis and the extra contribution to the river during storm periods was analyzed using STORM. Since quality data for the CSO's was not available at the loading point to the Chattahoochee River and analysis of tributaries to the mainstem was beyond the scope of this study, this superposition procedure was the best remaining approach.

Biochemical Oxygen Demand (BOD)

The BOD data from all sources were corrected from a total five-day BOD to a dissolved carbonaceous 5-day BOD required by the model by the following equation:

TABLE V-5. SEWAGE TREATMENT PLANT CHARACTERISTICS

Plant		Mean Discharge mgd	Mean Discharge cfs	# of bypass points	# of over-flow points	Type of collect-or system	Ind. waste treated (mgd)	Type of Treatment	Other
RM Clayton Plant (R.M. 408.0)		47.6	74	2	5	BSC	0	Screening/communition, sedimentation, activated sludge, clarification, and chlorination	Combined sewage may bypass chlorination. 120 mgd capacity. New plant on-line by 8-1-74.
Cobb County Chattahoochee River Plant (R.M. 408.0)	Aug Sep Oct	7.7 7.9 6.4	12 12 10	0	1	SAN	0.03	Screening/communition, activated sludge, clarification, and chlorination	10 mgd capacity
Sandy Creek (R.M. 403.1)		2.2	3					Apparent screening/communition and sedimentation	
South Cobb Plant (R.M. 401.3)	Aug Sep Oct	7.6 7.1 6.3	12 11 10	0	1	SAN	0.05	Screening/communition, activated sludge, clarification, and chlorination	8 mgd capacity
Fulco (R.M. 400.6)		1.1	2					Screening/communition and sedimentation	
Utoy Creek (R.M. 399.0)		7.3	11	0	0		1.00	Screening/communition, sedimentation, activated sludge, clarification, and chlorination	30 mgd capacity
Camp Creek (R.M. 391.2)		6.0	9	1	0	SAN	0.18	Screening/communition, sedimentation, activated sludge, clarification, and chlorination	15 mgd capacity. New plant on-line by 8-1-74.

Notes: (1) Type of collection system: BSC = both sanitary and combined
SAN = sanitary only.

(2) Significant quantities of flow bypassed the R.M. Clayton treatment plant during the period of study.

$$CBOD5 = TBOD5 - (NH3)\ O2NH3\ (1-e^{-KNH3(5)}) \quad \text{V-4}$$

$$- (NO2)\ O2NO2\ (1-e^{-KNO2(5)}) - (DET)\ O2DET\ (1-e^{-KDET(5)})$$

where

CBOD5 = 5-day dissolved carbonaceous BOD in mg/l

TBOD5 = total dissolved and suspended 5-day BOD in mg/l

NH3 = ammonia-nitrogen in mg/l

O2NH3 = stoichiometric equivalence between DO and NO2

KNH3 = decay rate of ammonia at 20°C

NO2 = nitrite-nitrogen in mg/l

O2NO2 = stoichiometric equivalence between DO and NO2

KNO2 = decay rate of nitrite at 20°C

DET = detritus (volatile solids) in mg/l

O2DET = stoichiometric equivalence between DO and detritus

KDET = decay rate of detritus (volatile solids) at 20°C.

This correction is made automatically in the preprocessor so that the user can input the normally available total dissolved 5-day BOD, TBOD5.

Recommended Data Collection Improvements

Many important concepts and ideas were generated during the one year duration of this study. Many of these ideas were used in the model development, some were used in establishing suitable input data where lack of recorded data was apparent, and others are to be documented in this section as to how the study could have been improved if things could have been different.

First on any modeler's list of improvements needed is the necessity of having more and better quality input data. Many examples exist, in the data available for this study, where two or more agencies have collected data on the same day and have recorded widely varying values. While it is physically possible for this to happen, one might question the common occu-

rence of this data variability. A recommendation for minimizing the doubt of the acceptability of this data variability is to insure the data users of the laboratory's quality control and the qualifications of the field sampling teams by establishment of a sensitive rating system. If these ratings could be recorded on the data sheets, the data users could apply appropriate weightings to the recorded data before using the data for analysis. Under the present system, all the data are given the same weight regardless of the laboratory or field personnel involved in the sampling and analysis.

More data are always recommended but proactical limits must be found to balance the incremental increase in modeling analysis accuracy against the increased cost of collecting more data. An economic balance is obviously beyond the scope of this study but practical suggestions can be made regarding the lack of needed data. Collection of the following data is recommended in order of priority:

1. Storm runoff quality data collected at several (i.e., 3 to 5) sites during two or three storm events,
2. Better quality control and maintenance control on the data collected at Buford Dam,
3. Discharge data always measured or estimated whenever an agency collects water quality data,
4. Much better monitoring of effluents from the sewage treatment plants, particularly from the R.M. Clayton plant, including records on the quantity and quality of flows bypassing the treatment system,
5. Measured discharge at Morgan Falls,
6. Monitoring effluents for at least temperature and DO at all industrial outfalls, particularly the Atkinson-McDonough and the Yates power plants,
7. Recording the time of observation on all data sheets, and
8. Major expansion of the collection of biotic data.

Until better data are collected in the field during several storm runoff events, as suggested in recommendation 1, any dynamic (i.e., short interval) modeling effort will have significant problems reproducing observed data during the after storm periods because the time variability of runoff quality as well as the total loads can only be grossly estimated.

Recommendation 2 was suggested because of the experience in this study where the Buford monitor was found to be non-functional during 84 days out of the 92 day study period. The quality control at this point in the system is so important because it is the headwater (i.e., boundary condition) inflow and the largest inflow to the system (aside from the Atkinson-McDonough inflow which has been first withdrawn from the system and then used for cooling water only).

Examination of the loading and withdrawal data inventory (table III-1) shows that several of the tributaries are monitored regularly for water quality but no estimate is available for discharge. Without this quantity-quality coordination, as suggested in recommendation 3, the stream loadings can only be grossly estimated. If the collection points are sufficiently important to sample quality data on those tributaries, the U.S. Geological Survey or other agencies should seriously consider collecting discharge data at the same points.

Another significant input data problem experienced during the study prompted recommendatinn 4. The Chattahoochee River (Cobb Co.) and South Cobb sewage treatment plants had daily records on discharge, BOD, pH, chorine and suspended solids but the R.M. Clayton, Sandy Creek, Fulco, Utoy Creek and Camp Creek plants had only yearly averages, minimums and coliform, DO, NH_3, PO_4, and temperature are also needed and at least weekly records should be maintained. The R.M. Clayton plant records were furnished by the State with a note suggesting that substantial amounts of unmonitored influents bypassed the system during the period of study. Some estimate is needed of the quality and quantity of all influents bypassing any treatment plants.

Recommendation 5 is important because the velocities in the Morgan Falls impoundment have to be so grossly estimated that calculated discharges are almost useless. The accuracy of the cross sections in Morgan Falls impoundment are sufficiently questionable, due to continually occurring sedimentation, that the velocities in any section are not reliable. This study used estimated discharges based on recorded power generated, recorded head and an estimated efficiency rating.

Effluent records from industrial outfalls are generally not readily available. While they are not always extremely important to an accounting of masses in the system because their discharge is usually small, any discharge of pollutants of greatly different concentrations than the receiving water concentration offers potentially significant errors in a mass accounting. Examples of the importance of recommendation 6 are the effluents from Georgia Power's Atkinson-McDonough and Yates power plants.

These recommendations are made in an effort to improve the data situation on the Chattahoochee so that further modeling efforts may more closely simulate the existing condition and so that the evaluation of the impacts of proposed alternative plans of development for the basin can be more realistic. They are not intended and it is hoped they will not be considered by anyone to be a criticism of the data collection efforts presently in progress. The data provided for this study were of better quality and more voluminous than the data this modeler has ever found available on previous studies.

The time of sample collection must be recorded, as suggested in recommendation 7, so that true error can be determined in modeling studies.

Recommendation 8 is extremely important to future modeling efforts. Besides suggesting major expansion of the collection of biotic data, the present data collection program needs critical review by an interdisciplinary team of biologists and water quality modelers.

VI. MODEL RESULTS

Analysis of Existing Conditions

General

The analysis of existing conditions with the use of a mathematical model is usually done for the purpose of (1) calibration of the model for use as a predictive tool, with existing conditions, (2) allowing the modeler to develop some degree of confidence in the model as a predictive tool, and (3) preparing to perform a predictive analysis on physical conditions that are somewhat different than the existing conditions (e.g., channel alignment project).

The distinction between calibration and verification of a mathematical model requires definition for this specific study since these words are often used interchangeably. The term calibration refers to adjusting model coefficients which can only be defined by site specific characteristics. The term verification refers to using a calibrated model to predict a condition somewhat different than the condition on which it was calibrated and then to check the predicted results against observed field data.

The error in reproduction of observed data, using a water quality model, can be caused by several phenomena besides modeling inadequacies. The error can be caused by (1) sampling data in a stream section that is not fully mixed in either the vertical or lateral dimensions, (2) laboratory error in analysis (i.e., inadequate quality control), (3) field sampling problems with preservation of the sample to insure minimum change in the sample between the field and the laboratory, and (4) the lack of observed input data for loadings and tributaries. This last point is a major cause of problems in most studies.

Careful examination of some of the observed field data shows that one or more of these causes of error probably contributed to reproduction problems. On several occasions, field samples were collected by different agencies on the same day but the reported results from the laboratory analysis are significantly different. This situation is not unusual

in modeling efforts but should be mentioned prior to any discussion of the modeling calibration effort.

Model Calibration

On the Chattahoochee River study, the calibration was completed using observed field data from reach I for the first 15 days of August 1974. The results of the 15 days of simulated data were compared against the observed data from 7-8 August and 13-15 August. The only coefficient adjustments required to calibrate the model consisted of increasing the ammonia and nitrite decay coefficients in order to better reproduce the ammonia and nitrate observed data. The coefficients used for this study are shown in Appendix F.

Originally the fecal coliform input data used at each tributary or load point was a 3-month average value. During the calibration simulation an attempt was made to improve the coliform reproduction by using mean monthly fecal coliform as input. The resulting simulation was a slight improvement over the previous simulations and the mean monthly input interval for fecal coliform data was adopted.

Model Verification

Following completion of the model calibration on reach I using the two sampling periods in the first 15 days of August, the model was used to simulate the remainder of the study period on reach I and the entire study period on reaches II through VI. Comparisons were then made between calculated and observed data but without applying any further adjustment to the coefficients.

Results

The model simulations resulted in output every 2 hours at every node (i.e., every mile in reach I, every .5 mile in reaches II-IV, and every 2 miles in reaches V-VI) for each water quality parameter. A magnetic tape was produced during the simulation runs for use by a post-processor program which is presently undergoing developmental work.

The post-processor program produced graphical output for 8 parameters (i.e., temperature, DO, NH_3, NO_3, PO_4, pH, TDS, and fecal coliform) showing the calculated and observed values. Samples of the graphs are shown in figures VI-1 through VI-8. These sample graphs depict the computer simulated results at the Atlanta USGS streamflow gage (i.e., river mile 410.7).

These graphs were examined for each parameter at each sampling location. The individual observed errors (i.e., the difference between the observed data and the calculated curve) were recorded and the mean error ($\bar{X}$) and standard deviation of the errors were calculated for each parameter. These calculated statistics are shown in table VI-1.

The maximum computed value for each date and for each parameter was obtained from the graphs. Combining the maximum computed value during the 3 months and the mean error for the associated point and parameter, envelope or maximum curves were constructed for all parameters listed above except DO.

It is important to clarify that these envelope curves are developed by studying only the 3 months of August through October 1974. Obviously, higher concentrations can occur due to causes which were not represented during this study period. Examples of causes that might generate worse conditions include (1) climatic and seasonal conditions not represented during this study period, (2) operational failure of one or more treatment plants, (3) lower releases from Buford Dam and Morgan Falls than were experienced during this study, and (4) higher concentrations of storm water pollutants or tributary loads than were experienced during this study. With these qualifying remarks in mind, the envelope curves can be thought as "maximum normally expected" water quality stream profiles.

"Minimum normally expected" stream profiles were constructed in a simular manner to the method used for the maximum curves. Minimum curves were developed for temperature, DO, and pH. The stream profiles for the maximum and minimum curves are shown in figures VI-9 through VI-16.

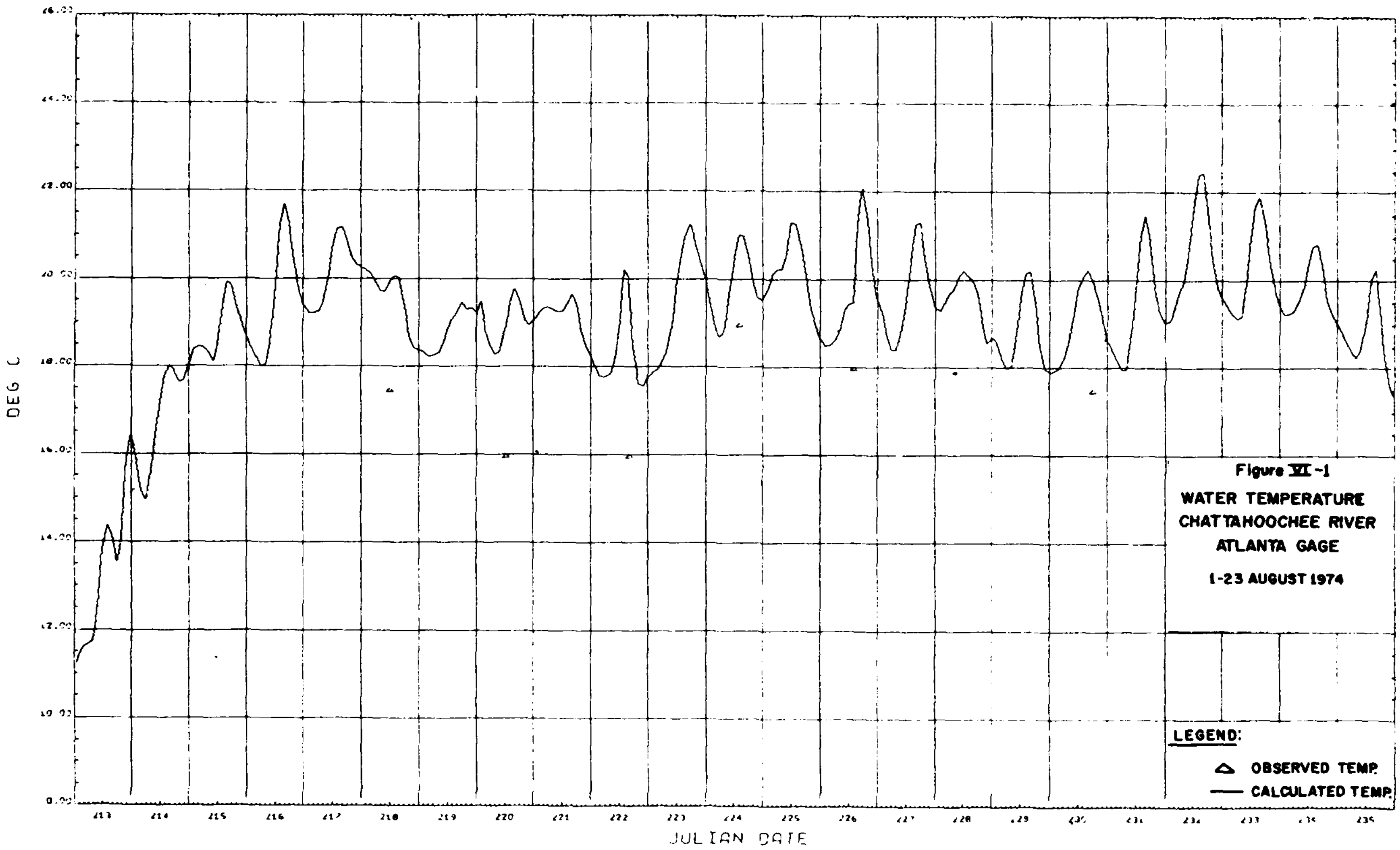
Figure VI-1
WATER TEMPERATURE
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974
LEGEND:
OBSERVED TEMP.
CALCULATED TEMP.
DEG C
JULIAN DATE
0.00
12.00
14.00
16.00
18.00
20.00
22.00
213
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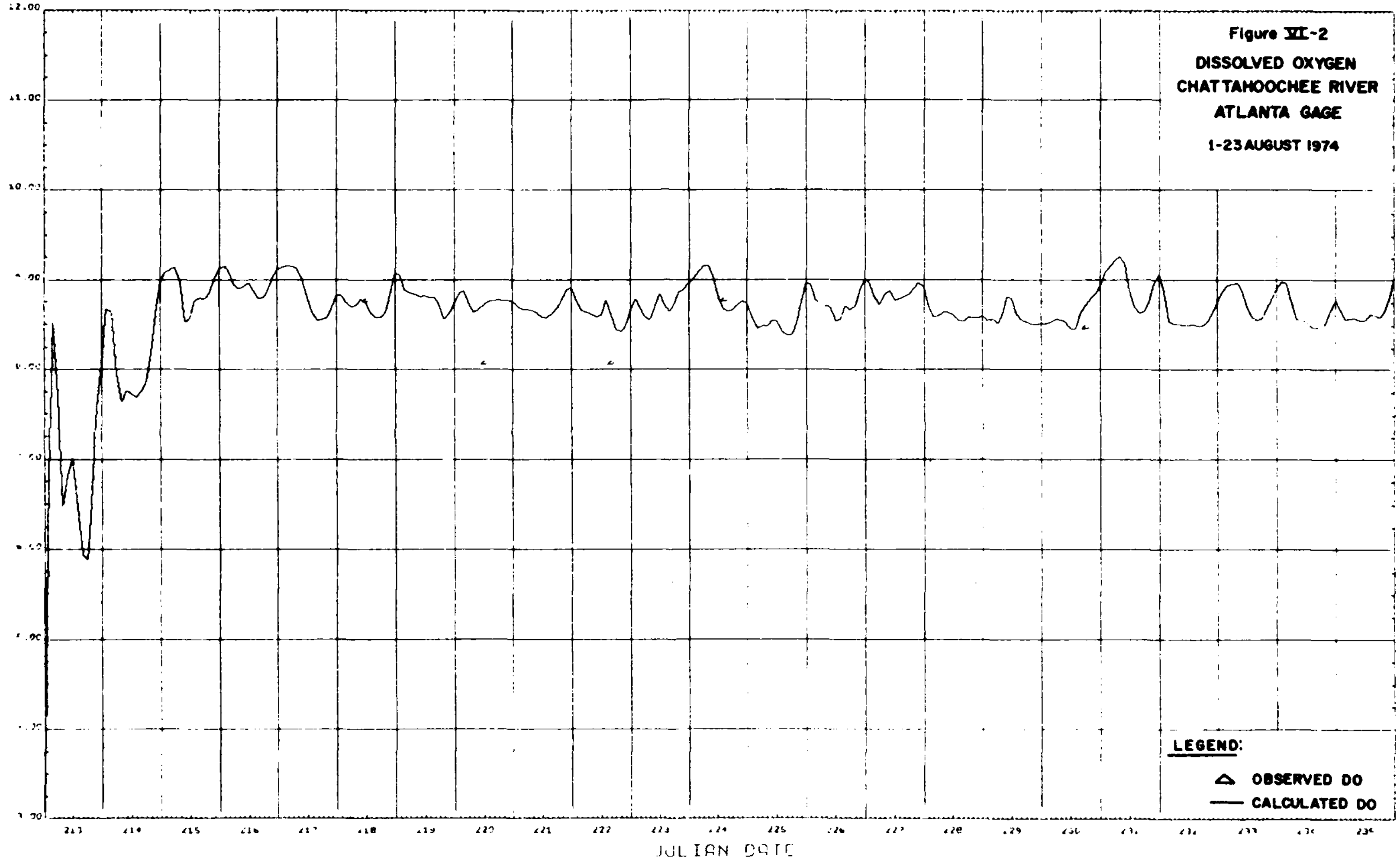


Figure VI-2
DISSOLVED OXYGEN
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974

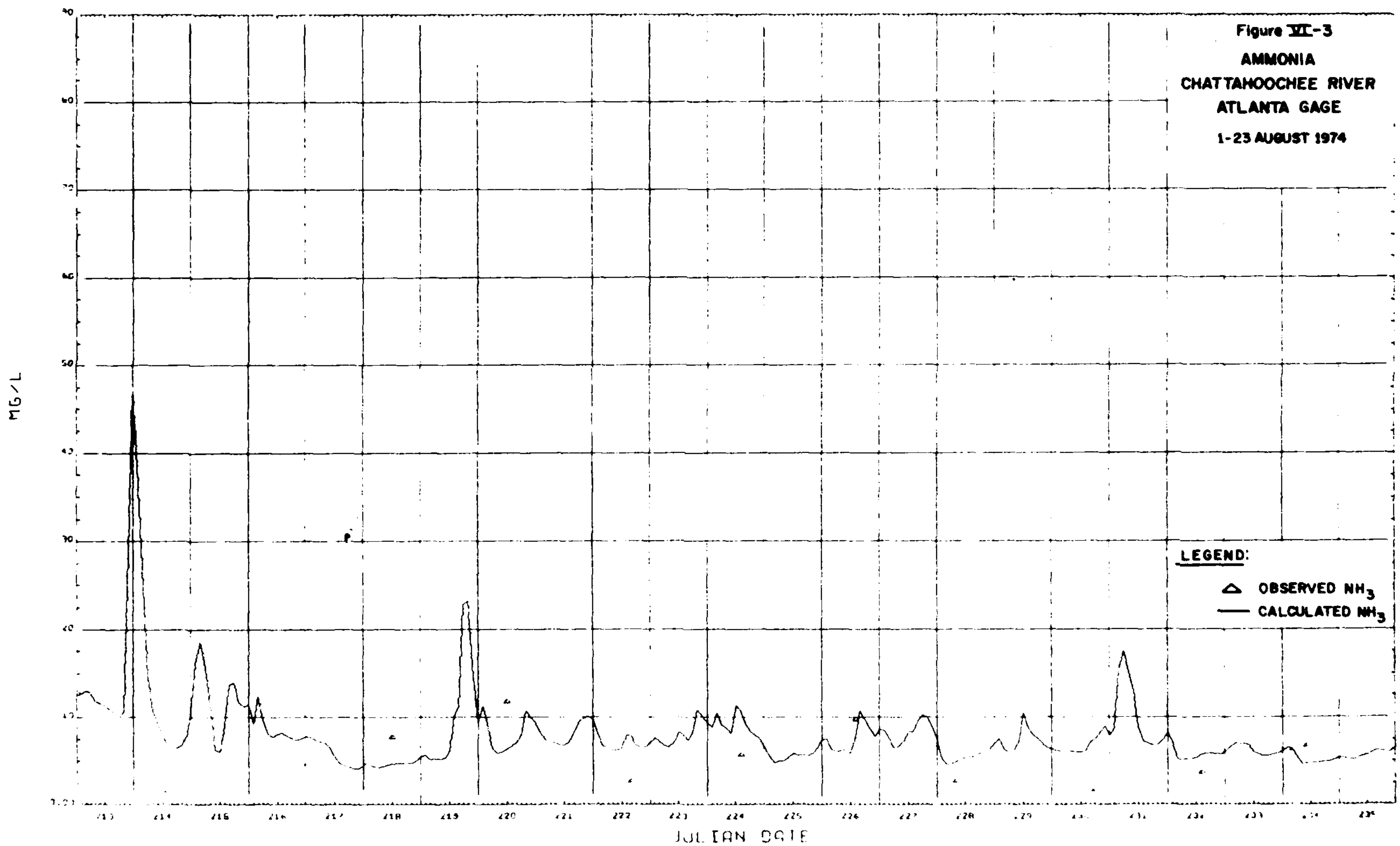


Figure VI-3
AMMONIA
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974
LEGEND:
OBSERVED NH_3
CALCULATED NH_3
MG/L
JULIAN DATE

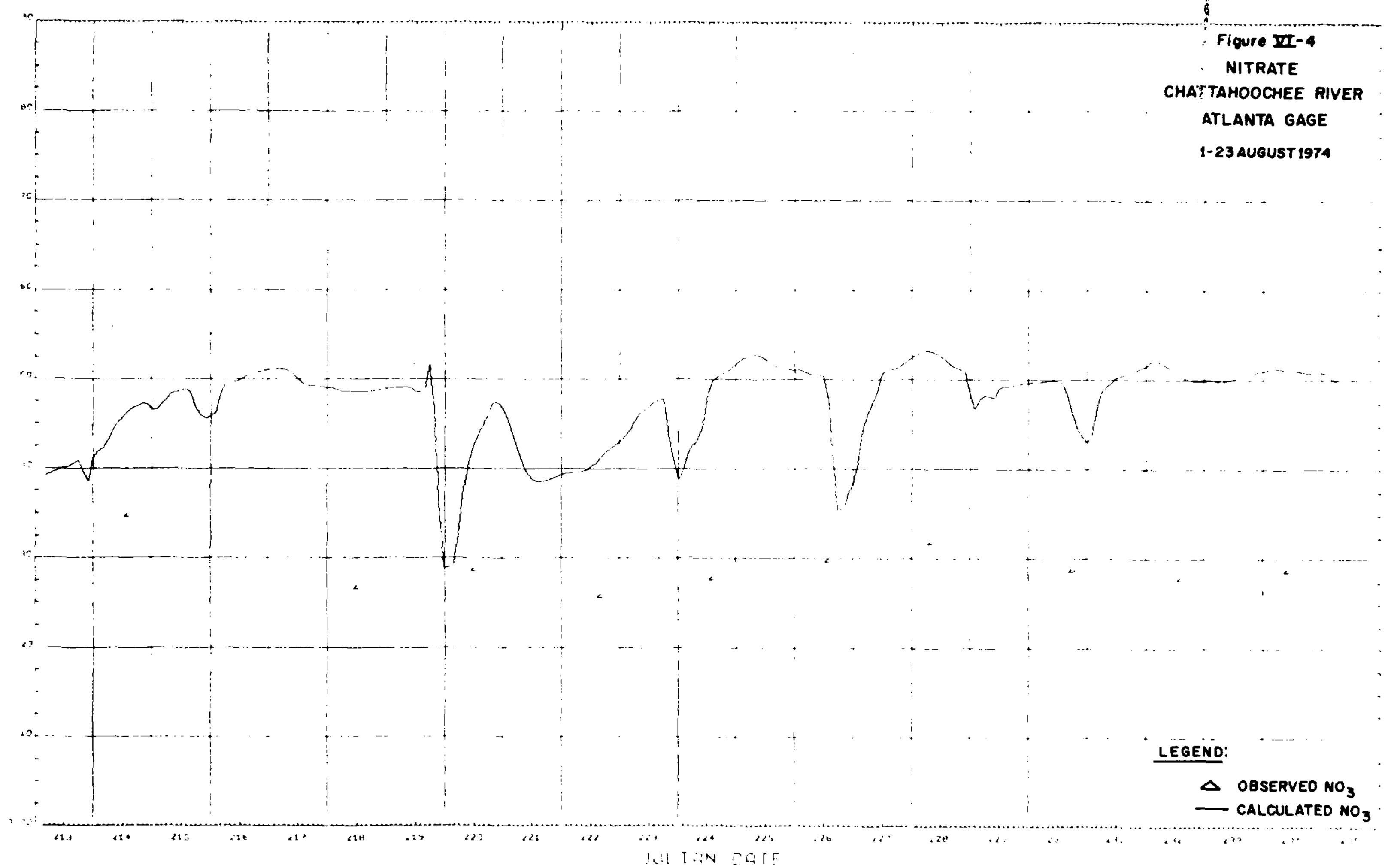


Figure VI-4
NITRATE
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974
LEGEND:
OBSERVED NO_3
CALCULATED NO_3
MG/L
JULIAN DATE

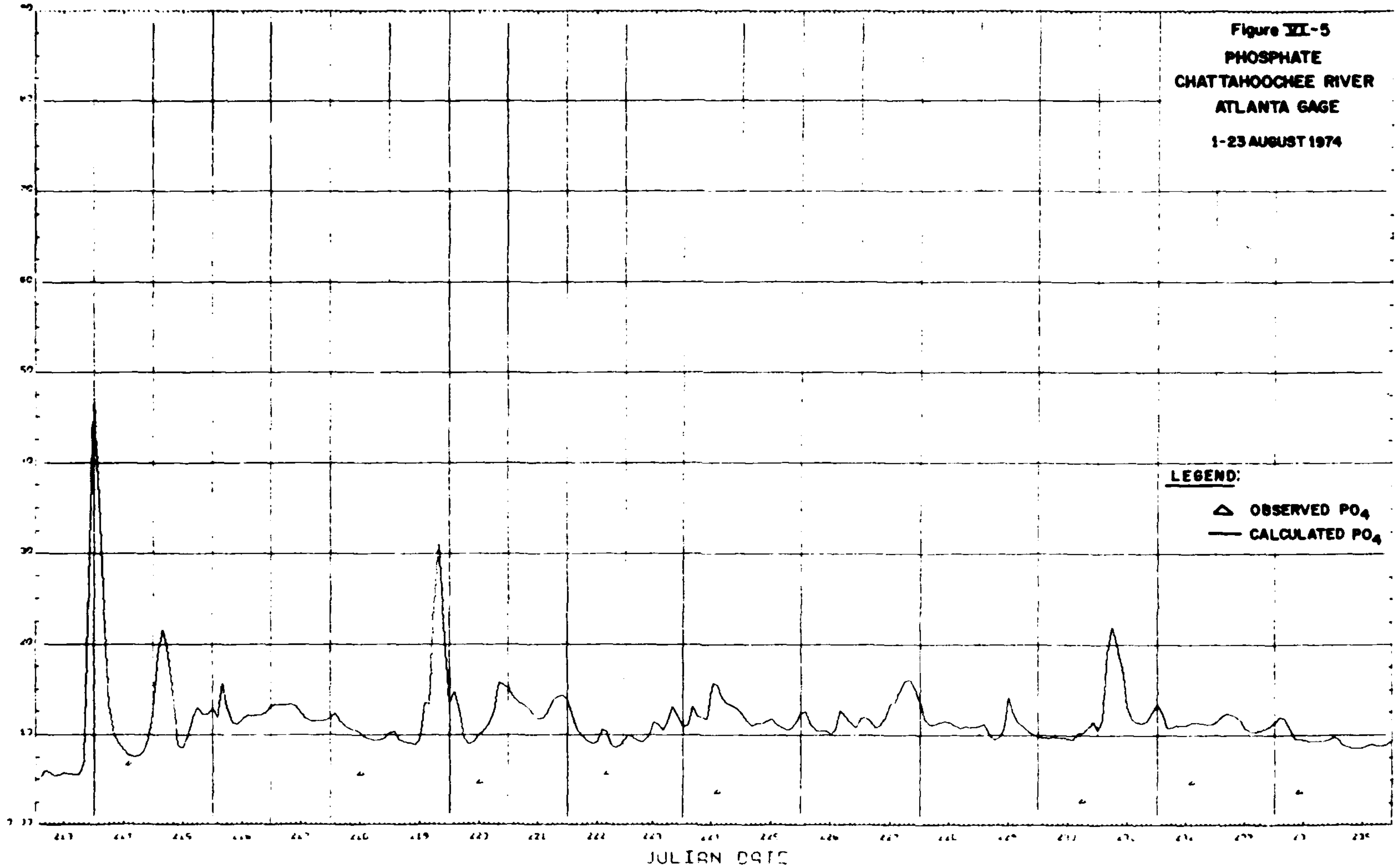


Figure VI-5
PHOSPHATE
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974

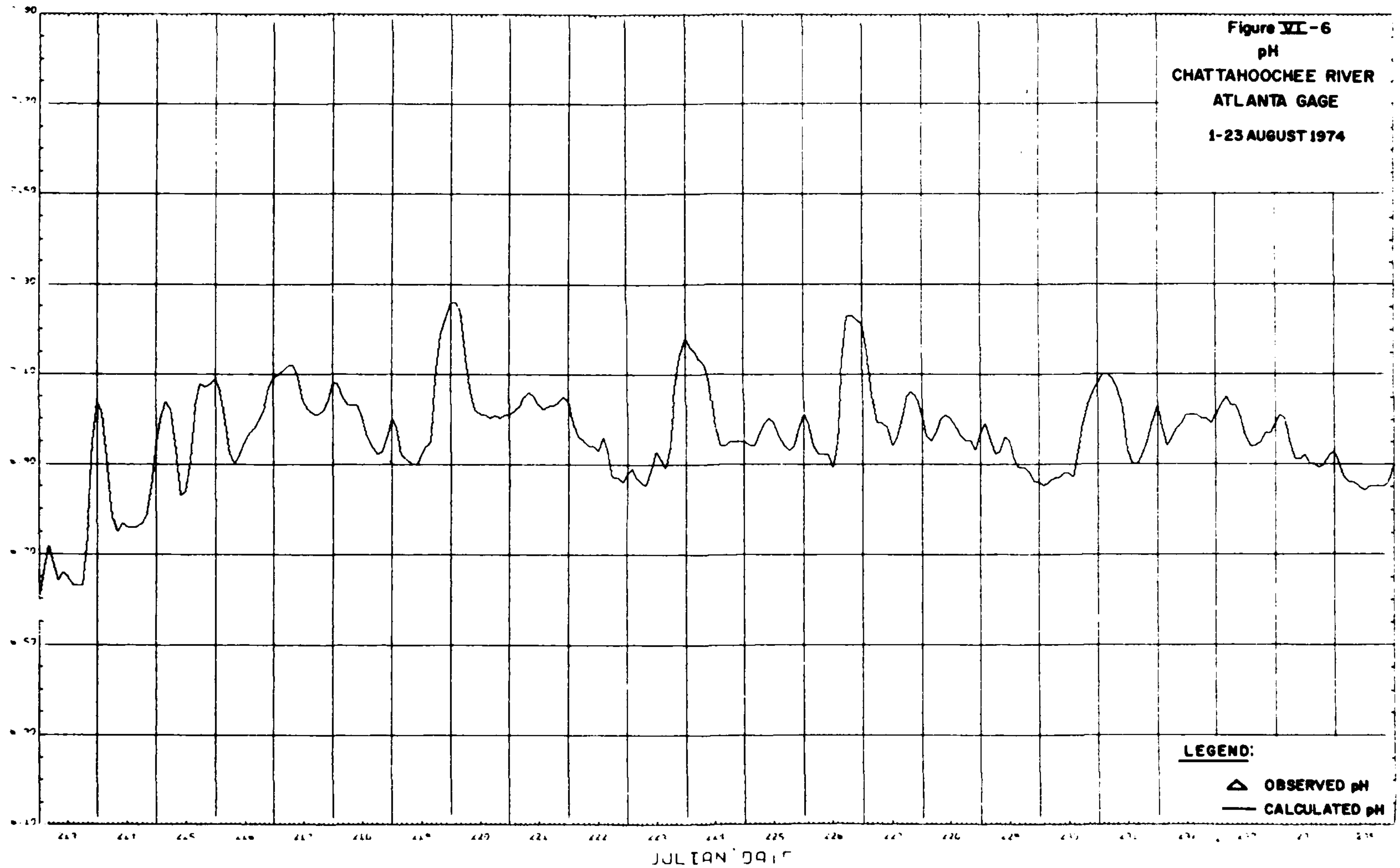


Figure VI-6
pH
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974
LEGEND:
OBSERVED pH
CALCULATED pH
JULIAN DATE

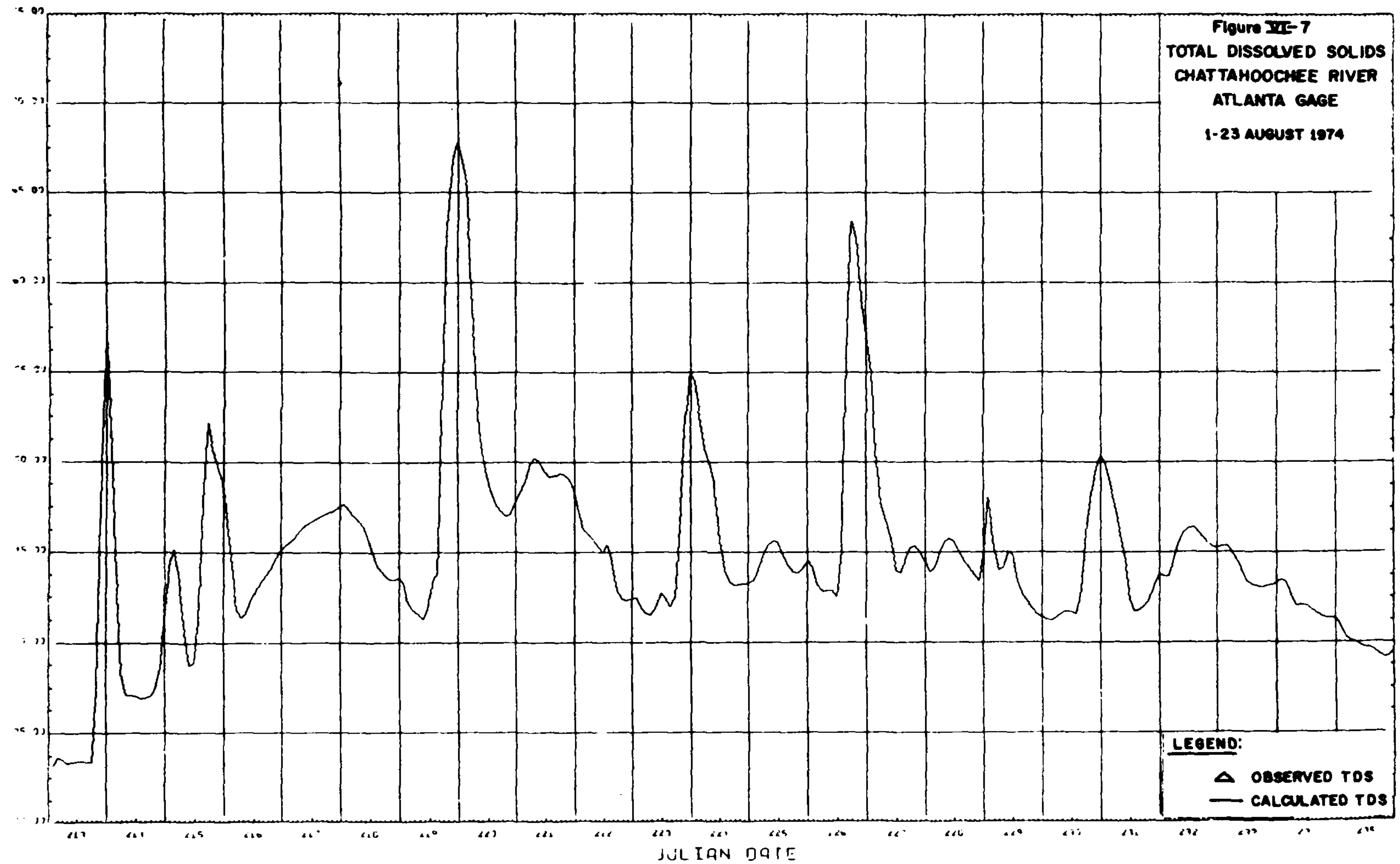


Figure VI-7
TOTAL DISSOLVED SOLIDS
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974
LEGEND:
OBSERVED TDS
CALCULATED TDS
JULIAN DATE
MG/L

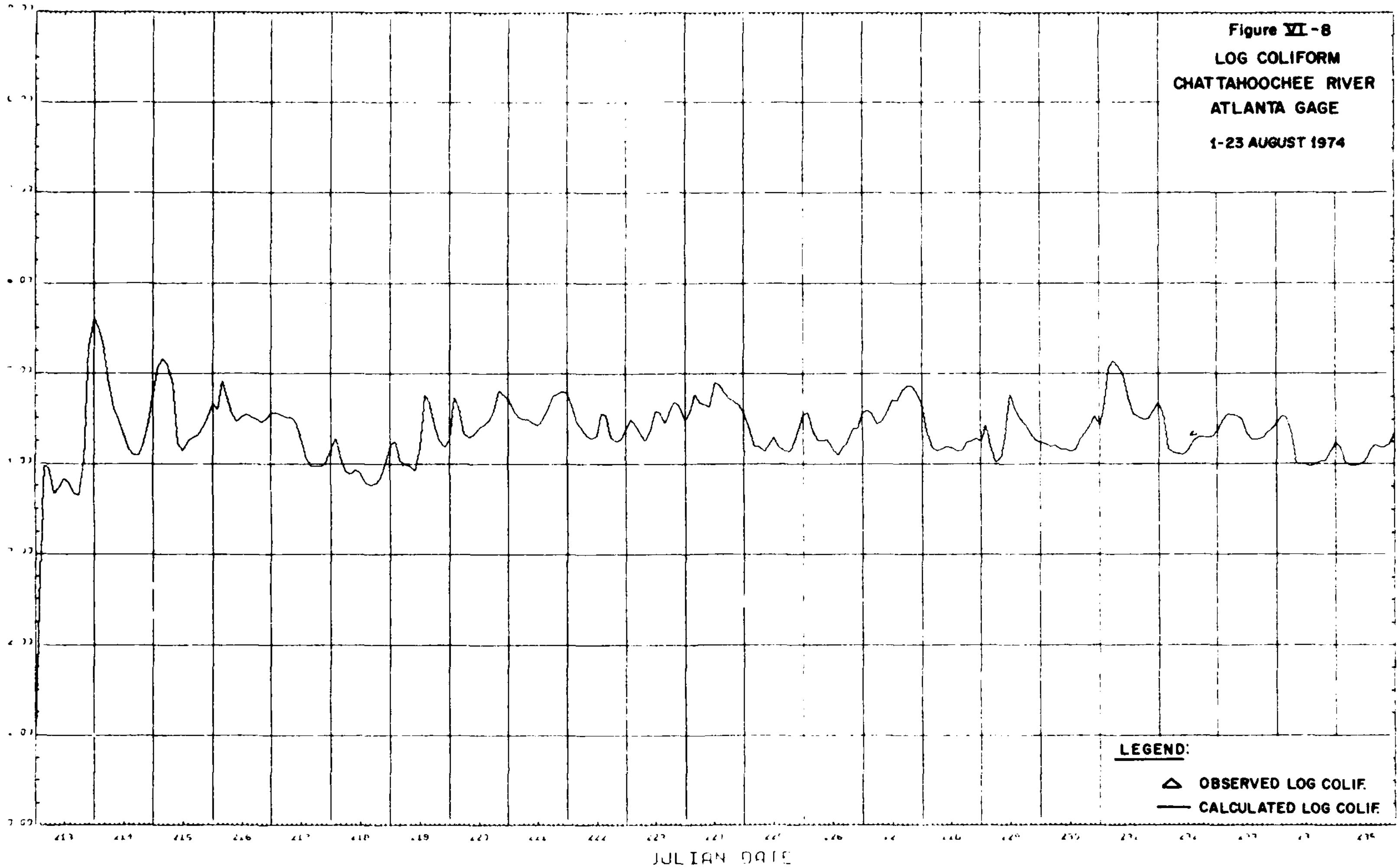


Figure VI-8
LOG COLIFORM
CHATTAHOOCHEE RIVER
ATLANTA GAGE
1-23 AUGUST 1974

TABLE VI-1

ERROR OF REPRODUCTION STATISTICS

Parameter	Error Statistic	End of Reach 1	2	3	4	5	6
Temperature (°C)	Mean	-.5	-.1	-.1	-.2	-.6	-.9
	S	1.3	1.8	.7	1.3	1.5	1.4
DO (mg/l)	Mean	-.1	.6	1.1	1.6	3.4	1.8
	S	.2	.4	.8	.8	.6	.6
NH3 (mg/l as N)	Mean	.04	-.04			-.33	
	S	.16	.10			.31	
NO3 (mg/l as N)	Mean	-.01	.13			.72	
	S	.39	.23			.47	
PO4 (mg/l as P)	Mean	-.01	.05			.15	
	S	.08	.11			.31	
pH	Mean	.0	-.2				
	S	.1	.5				
TDS (mg/l)	Mean	1.8	-2.1				
	S	18.8	12.1				
Log Fecal Coliform (colonies/ 100 ml)	Mean	0	-.2				
	S	.5	.6				

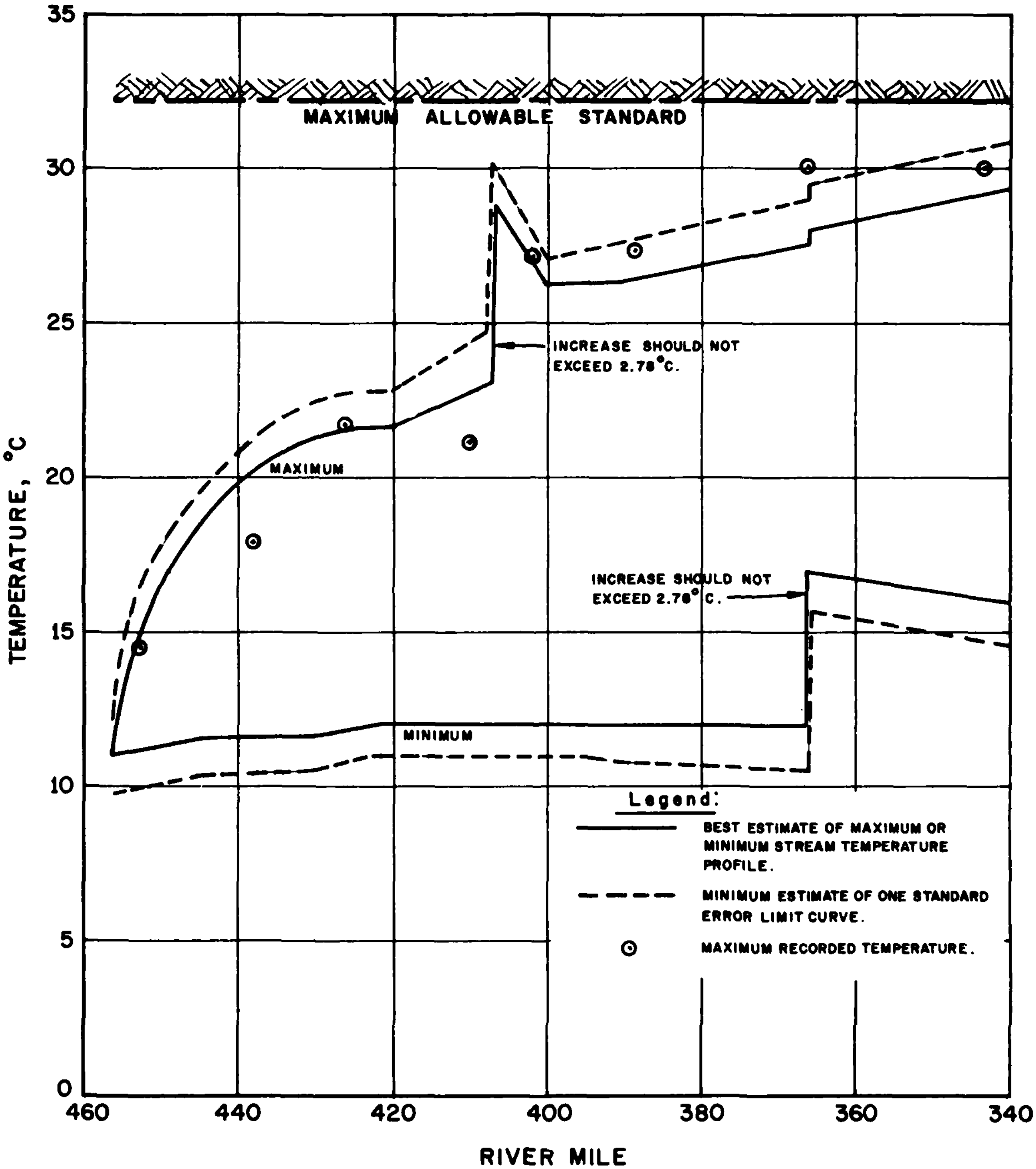


Figure VI-9 MAXIMUM AND MINIMUM NORMALLY EXPECTED STREAM TEMPERATURE PROFILES FOR AUGUST-OCTOBER

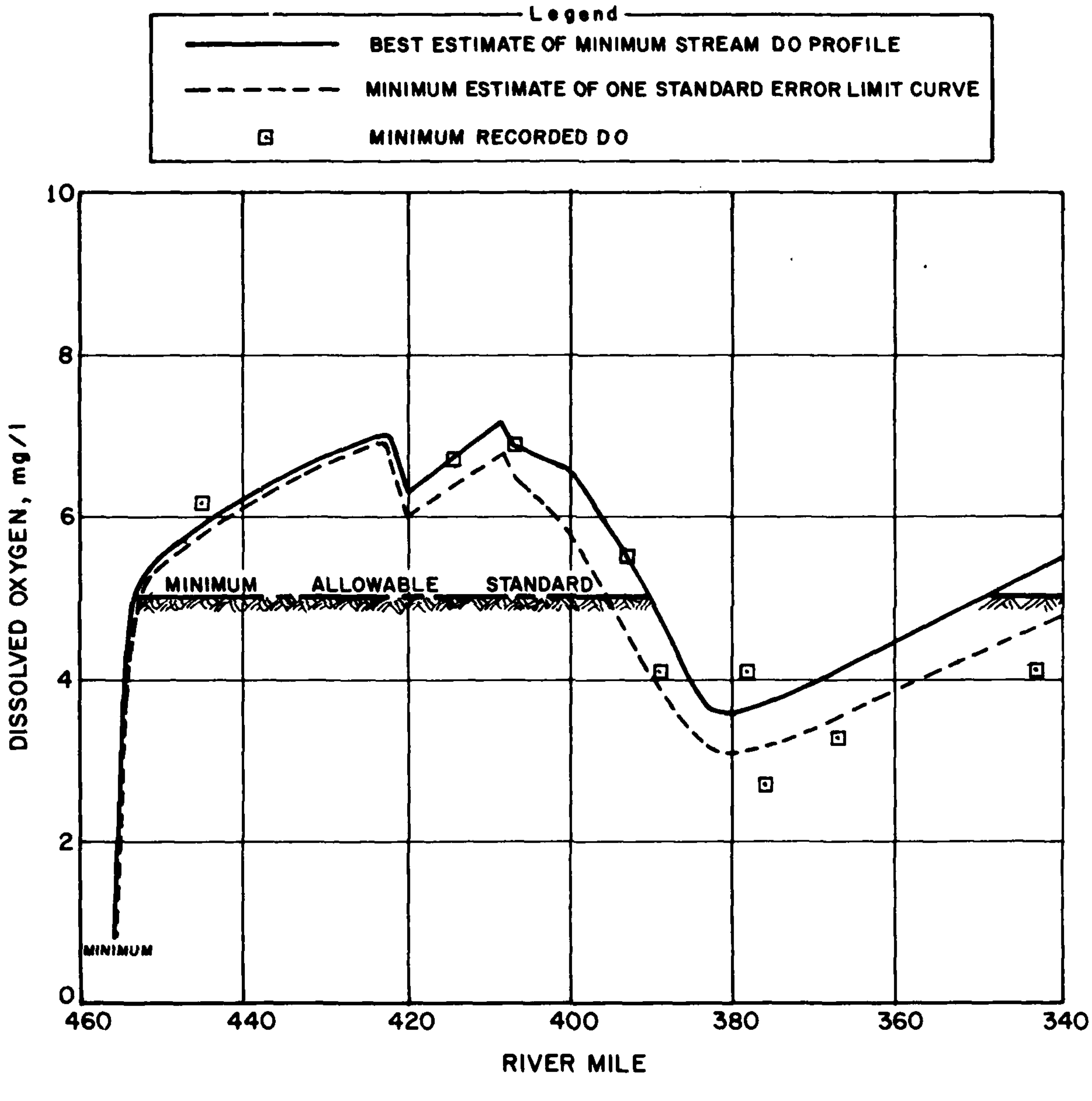


Figure VI-10. MINIMUM NORMALLY EXPECTED DO STREAM PROFILE FOR AUGUST-OCTOBER

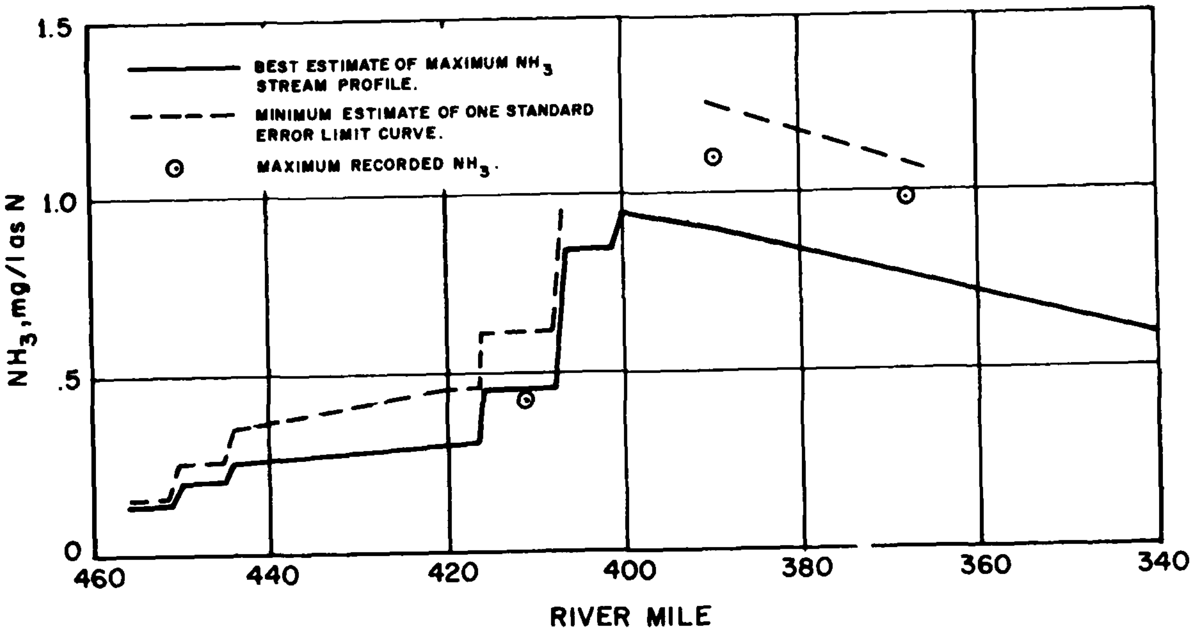


Figure VI-11. MAXIMUM NORMALLY EXPECTED NH_3 STREAM PROFILE FOR AUGUST-OCTOBER

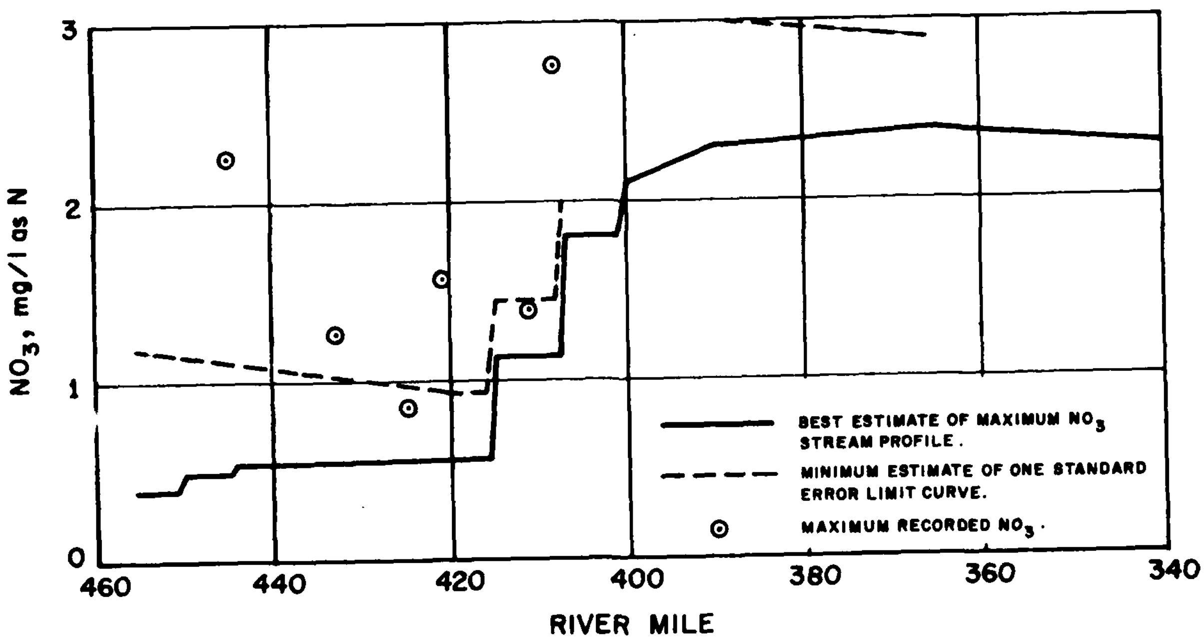


Figure VI-12 MAXIMUM NORMALLY EXPECTED NO_3 STREAM PROFILE FOR AUGUST-OCTOBER

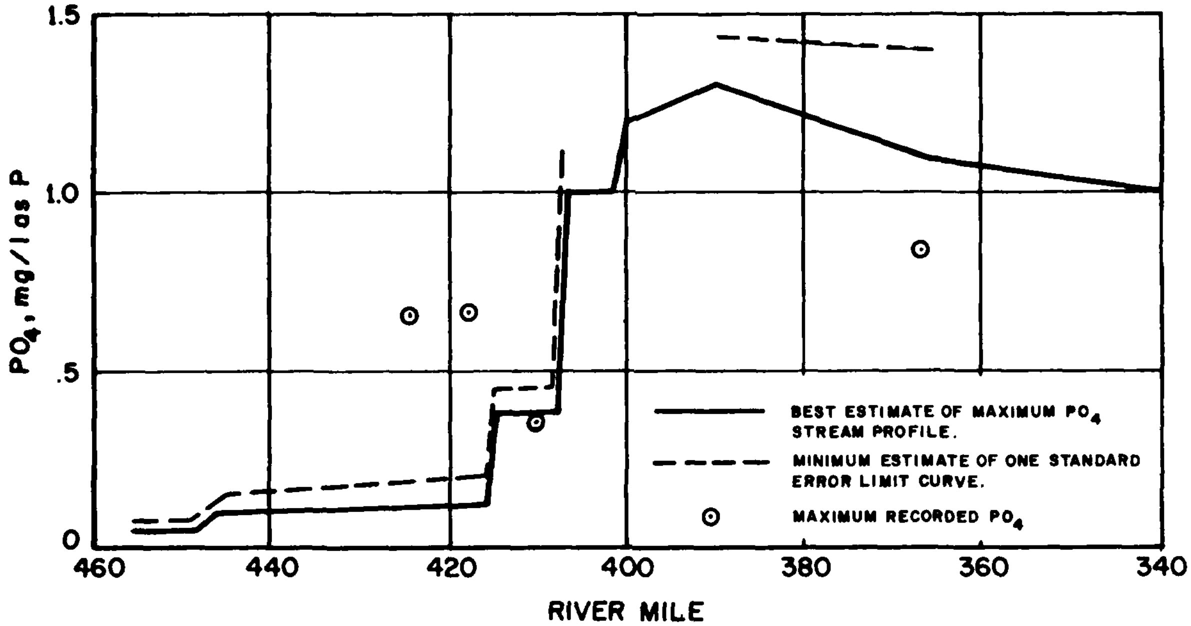


Figure VI-13. MAXIMUM NORMALLY EXPECTED PO_4 STREAM PROFILE FOR AUGUST-OCTOBER.

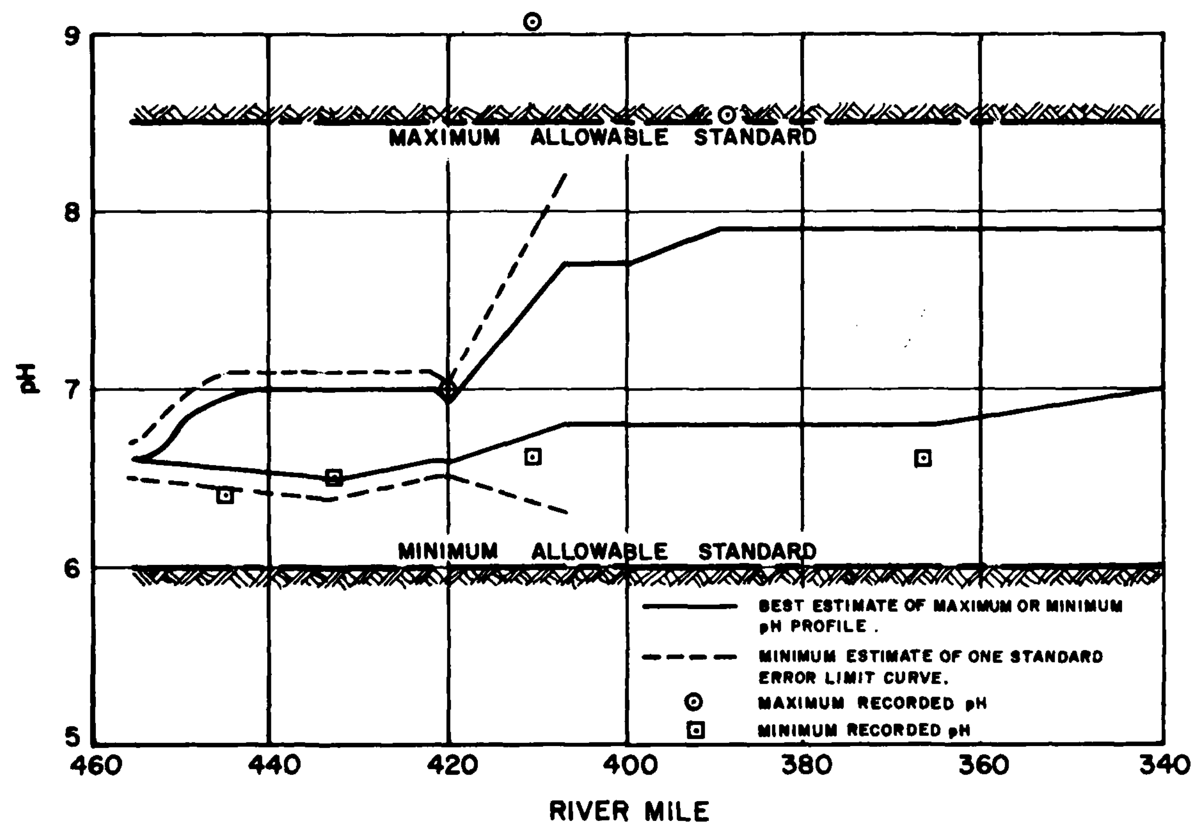


Figure VI-14. MAXIMUM AND MINIMUM NORMALLY EXPECTED pH STREAM PROFILE FOR AUGUST-OCTOBER.

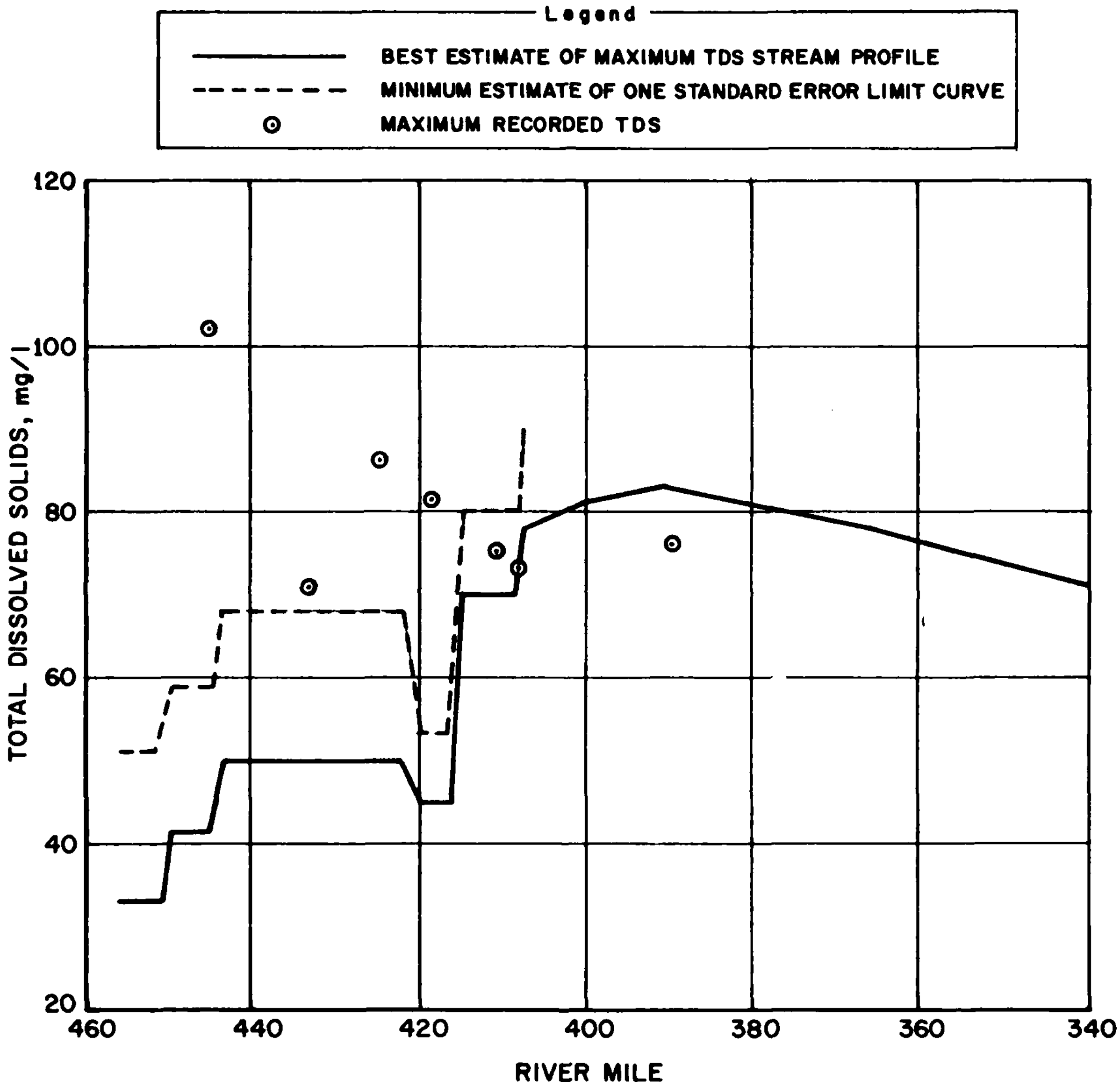


Figure VI-15. MAXIMUM NORMALLY EXPECTED TDS STREAM PROFILE FOR AUGUST-OCTOBER

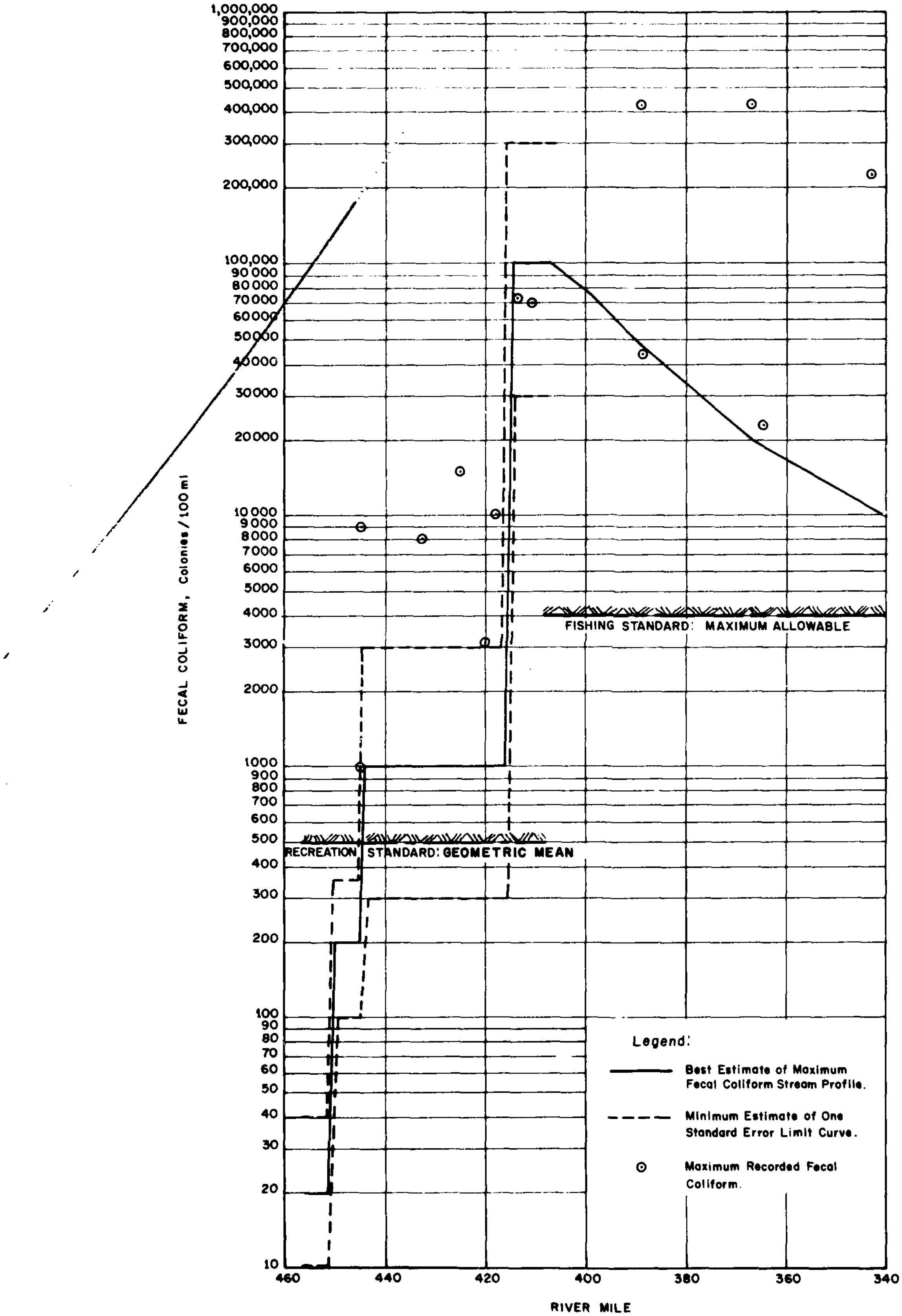


Figure VI-16. MAXIMUM NORMALLY EXPECTED FECAL COLIFORM STREAM PROFILE FOR AUGUST-OCTOBER.

An estimate of one standard error (i.e., if the true error was known and used, an 84% confidence error limit curve) above the maximum curve and below the minimum curve has been included for assistance in interpreting the confidence of a "best estimated value" from the curves. An example of the uses of these error limit curves might be beneficial. If an estimate of a "maximum normally expected" temperature at river mile 410.7 (Atlanta gage) is desired, figure VI-9 shows it to be 22.6°C with approximately 84% confidence. By doubling the distance between the "best estimate" curve and the error limit curve, it can be estimated that the "true" value would not be expected to exceed 25.8°C with approximately 98% confidence.

Comparison With Water Quality Standards

1. General. A copy of the Georgia state stream standards and the associated stream classifications has been included in appendix G. The relevant standards have been superimposed on figures VI-9 through VI-16 for comparison with the "maximum normally expected" or "minimum normally expected" existing conditions.

2. Temperature. Notice in figure VI-9 that although water temperatures for existing conditions normally do not exceed the 32.2°C (90°F) temperature standard, the heat effluent from Georgia Power's thermal power plants can potentially cause a receiving water temperature rise in excess of the allowable 2.78°C (5°F). This potential violation of the standards based on the calculated values was caused by using a constant input from the thermal plant running at full capacity. In practice Georgia Power attempts to monitor their effluents to prevent this from occurring. The modeling effort did not attempt to simulate the actual hourly variations in cooling water flows. No other temperature problems seem to be apparent.

It is interesting to note that water temperature variations during a day were often as large as 5°C (9°F). This rather large diurnal variation was substantiated by examination of AWW's continuous recorder charts which result from monitors located at several points along the Chattahoochee River and from thermal studies by Dr. Edinger (7).

This large variation in daily temperature is caused by large diurnal differences in stream velocities which are due to the hydropower operations at Buford Dam and Morgan Falls. When the stream velocities are lowest [i.e., reservoir releases less than 20 cms (706 cfs)], the amount of time that a given unit of water is exposed to short wave radiation is approximately twice as long as when the stream velocities are highest [i.e., hydropower releases in excess of 225 cms (7945 cfs)]. This dependency between the stream water quality condition and the river hydraulics is the reason for the importance of using a dynamic river water quality model.

Diurnal water temperature variations were usually around 1° to 2°C (1.8° to 3.6°F) during storm events. This again is due partially to the higher velocities in the stream system, but the cause must also be partially attributed to the meteorologic conditions during the storm period.

Examples exist where the stream temperature has been maintained between 11°C and 13°C down to Plant Yates. This was caused by high velocities and cool weather conditions.

Some maximum recorder temperature data have also been shown in figure IX-9.

3. Dissolved Oxygen. As shown in figure IX-10, the minimum DO profile will normally exceed the DO standard of 5 mg/l only in the reach from 3 miles below Buford Dam to Camp Creek. The DO in the remainder of the Chattahooche River will often go below the standard.

The portion of the river between Camp Creek and Franklin is a potential problem area for DO during adverse conditions. Observed data have been recorded in this reach of the river that substantiates these simulated results. Some minimum recorded DO data have also been shown in figure IX-10.

4. Plant Nutrients. The state standards for nutrient (i.e., NH_3, NO_3 and PO_4) concentrations are specified only in the river reach between Buford Dam and Peachtree Creek. In this reach, the nutrient concentrations

must not exceed the "Federal Drinking Water Standards." Although the concentrations shown in figures IX-11 through IX-13 are considerably below concentrations allowed for drinking water, it is important to note that they are all considerably above the concentrations which would tend to limit the growth of algae. While the growth of suspended algae (phytoplankton) was not simulated with the model, no visible level was encountered during field observations. This apparent lack of production was probably due to the turbidity normally present, rather than any nutrient limitations. If the turbidity was removed or decreased substantially, the potential would exist for rapid growth of algae in any slack water (i.e., low velocities) portions of the stream channel.

It should be noted in figures VI-11 through VI-13 that all the nutrient concentrations at the Fairburn gage are approximately double the concentrations at the Atlanta gage. The majority of this significant increase through the Atlanta urban area can be attributed to the 7 sewage treatment plants in this 21 miles of stream channel.

As shown in figures VI-12 and VI-13, the simulated results for NO_3 and PO_4 in the reach from Buford Dam to Atlanta are significantly low. While the calculated results cannot be relied upon as accurate simulations, the conclusions previously stated are undoubtably correct.

5. pH. The pH simulation results shown in figure VI-14 are always within the state standards. The one observed sample that exceeded the state standards was obtained at the Atlanta gage (i.e., river mile 410.7) during an intense storm period on 29 August. During the same storm event, a sample equal to the maximum standard was obtained at the Fairburn gage (i.e., river mile 389.4). Large pH values like these should only be expected to occur under very adverse conditions.

6. Total Dissolved Solids. The state standards on TDS are only [illegible] for the river reach between Buford Dam and Peachtree Creek. [illegible] reach the TDS concentrations must not exceed the "Federal Drinking [illegible]". The concentrations of TDS for the entire length of [illegible] in figure VI-15 to be well below levels required for [illegible] This conclusion is undoubtedly valid even though the

simulated results cannot be relied upon between Buford Dam and Atlanta.

The TDS concentration has a significant increase through the Atlanta urban area mostly due to the 7 sewage treatment plants in the 21 miles between the Atlanta and Fairburn gages.

7. Coliform Bacteria. The level of fecal coliform is probably the most serious problem in the Chattahoochee River. The state standards for the river reach from Suwanee Creek to Peachtree Creek are often exceeded for recreation uses as shown in figure VI-16, and from Peachtree Creek to Franklin for fishing. While several observed values lie above the simulated results, the conclusions remain the same as to the exceedence of state standards.

Cost Analysis

The computer costs on a high speed computer, like the CDC 7600 at the Lawrence Radiation Laboratory in Berkeley, are approximately $360 for simulating the 116 miles of river with 41 tributaries, load points and withdrawals for 92 days using hourly inputs. The cost may be increased by as much as 20% if excessive output is requested. Costs at commercial computer centers may be considerably higher.

Analysis of Modified Conditions

General

The study objectives included evaluating the impact on the water quality of the Chattahoochee River due to modifications of the effluent from existing sewage treatment plants (STP's) and from storm water runoff. Several levels of treatment are being considered as part of the Atlanta Urban Study. The scope of this study, however, allows for evaluating only one of the levels under consideration by Metro Atlanta

with the remaining levels to be evaluated in further studies.

The various levels of treatment under consideration are shown in table VI-2. The level identified as ABT-5" was selected by the Savannah District Corps of Engineers as the one level to be evaluated in this study. To be able to interface the treatment criteria provided with this specific modeling effort, it was necessary to make two assumptions. The level of treatment provided for P was assumed to be the same for PO_4 and the suspended solids level was assumed to be 25% detritus (volatile solids).

Modified Storm Water Runoff

To evaluate the impact due to modified storm water runoff, the results from STORM (i.e., quality of direct runoff) required modification prior to their use in calculating a mass balance with base flow in each tributary. Rather than correcting the data cards from STORM, the program logic was modified to check each water quality parameter from STORM against the BOD_5, NH_3, P and detritus (i.e., 25% of suspended solids) concentrations from table VI-2, treatment level ABT-5, and correct them to the specified level when appropriate. The DO concentration is not predicted by STORM, but whenever the base flow level was less than 6 mg/1, a mass balance between base flow and direct runoff was computed using the input value of DO for the base flow concentration and using 6 mg/1 for the DO concentration in the direct runoff.

Modified Sewage Treated Effluent

Preparation of a data deck for evaluating the impact due to modified sewage treatment plant effluents required changing only a few cards in the data deck for existing conditions. The existing condition data deck was modified only when the STP effluent concentrations for BOD_5, NH_3, PO_4 or detritus (i.e., 25% of suspended solids) exceeded the levels in table VI-2, treatment level ABT-5, or when the STP effluent concentrations for DO were less than 6 mg/1. Since reach I does not have any STP's, no evaluation in reach I was necessary.

TABLE VI -2

TREATMENT LEVELS

Treatment Level	Effluent Concentrations				
	BOD_5 (mg/l)	NH_3-N (mg/l)	P (mg/l)	D.O. (mg/l)	Suspended Solids (mg/l)
ABT-1	< 5	< 0.5	< 0.1	6.0	< 2.0
ABT-2	5	1.0	1.0	6.0	
ABT-3	10	2.0	1.0	6.0	
ABT-4	30	20.0	10.0	6.0	30.0
ABT-5	20	3.0	1.0	6.0	20.0

Comparison of Existing and Modified Conditions

Storm Water Runoff

The impact on water quality in the Chattahoochee River due to treating storm water runoff to the ABT-5 treatment level is insignificant under existing conditions. A relevant future study might be to evaluate this same impact after first improving the effluents from the major sewage treatment plants.

Sewage Treatment Plant Effluent

The impact on water quality in the Chattahoochee River due to improving treatment of sewage to the ABT-5 treatment level is quite insignificant. The improvements that can be expected in DO, NH_3 and PO_4 are summarized in table VI-3 and the stream profiles with and without the improved treatment are compared in figures VI-17 through VI-19. These graphs compare the "worst" normally expected existing condition with the "average" improvement for the modified condition. This comparison using the average improvement is considered to be more appropriate than using the maximum improvement, but both statistics are shown in table VI-3.

The DO improvement with ABT-5 treatment is significant but not sufficiently adequate to maintain a DO standard of 5 mg/l.

Since the NH_3 and PO_4 concentrations without the improved treatment were already below the state standards in the reaches below the first treatment plant, the improved condition may appear to be of minor consequence. However, the resulting improved condition is seen in figures VI-18 and VI-19 to have much less change in concentration compared to the concentration upstream of the Atlanta gage.

The predicted decrease in concentrations of the nutrients is sufficiently large to be of substantial potential significance in eutrophication of the Chattahoochee River system. If these changes in stream quality are considered as to their potential impact on water quality conditions in downstream impoundments (i.e., West Point Reservoir), the

TABLE VI-3

CHATTAHOOCHEE RIVER WATER QUALITY IMPROVEMENTS
DUE TO IMPROVED TREATMENT* OF SEWAGE

Parameter	Statistic of Improvement	End of Reach 2	3	4	5	6
DO (mg/l)	Maximum	+ .3	+ .5	+ .6	+ .9	+ .2
	Mean	+ .2	+ .3	+ .4	+ .5	+ .2
NH_3 (mg/l as N)	Maximum	- .45	- .55	- .40	- .20	- .10
	Mean	- .30	- .38	- .29	- .16	- .09
PO_4 (mg/l as P)	Maximum	- .83	-1.03	.1.00	-1.00	- .80
	Mean	- .56	- .69	- .69	- .73	- .74

*Improved treatment to ABT-5 level in table VI-2.

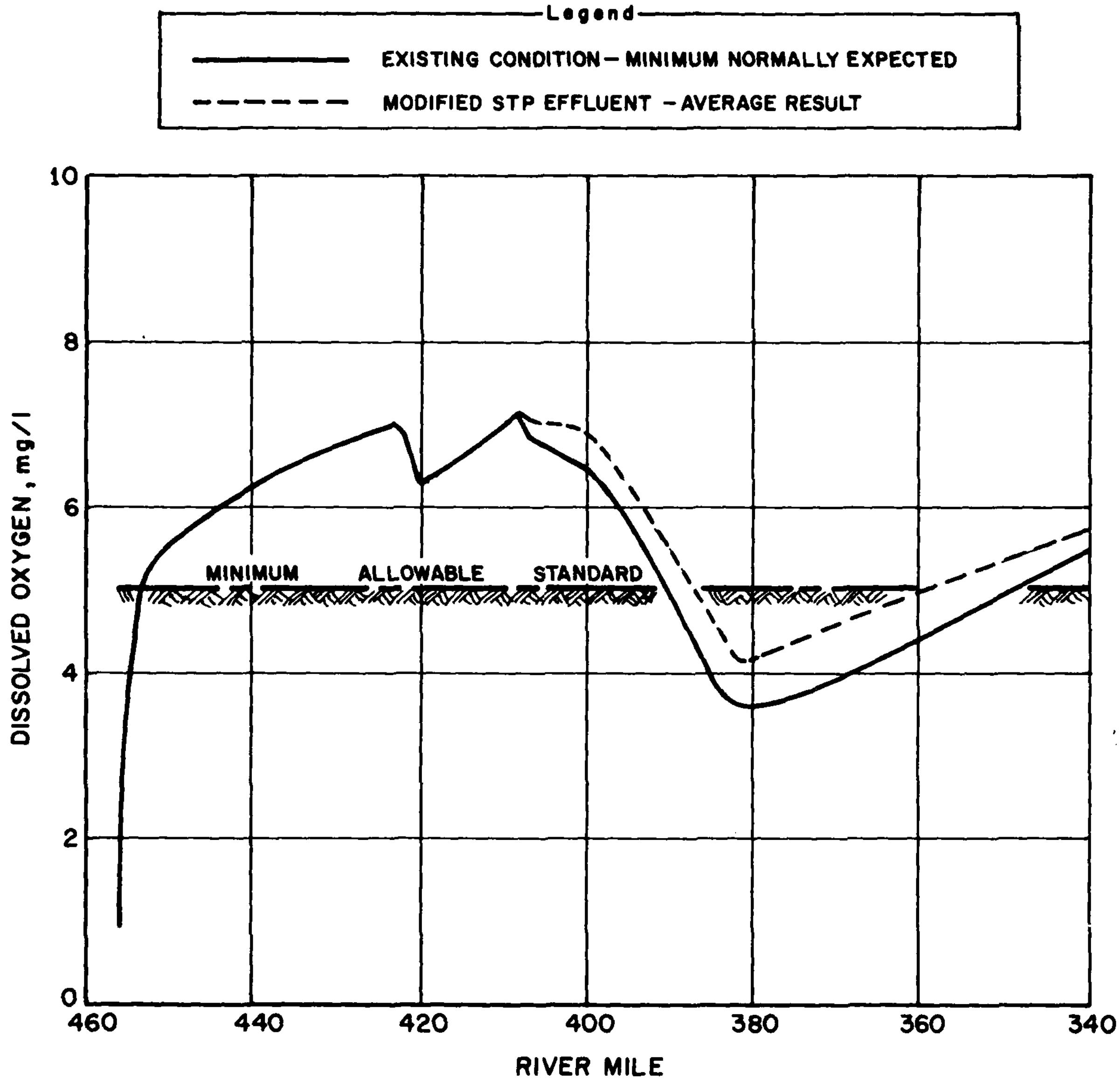


Figure VI-17. IMPACT ON DO DUE TO MODIFIED STP EFFLUENT

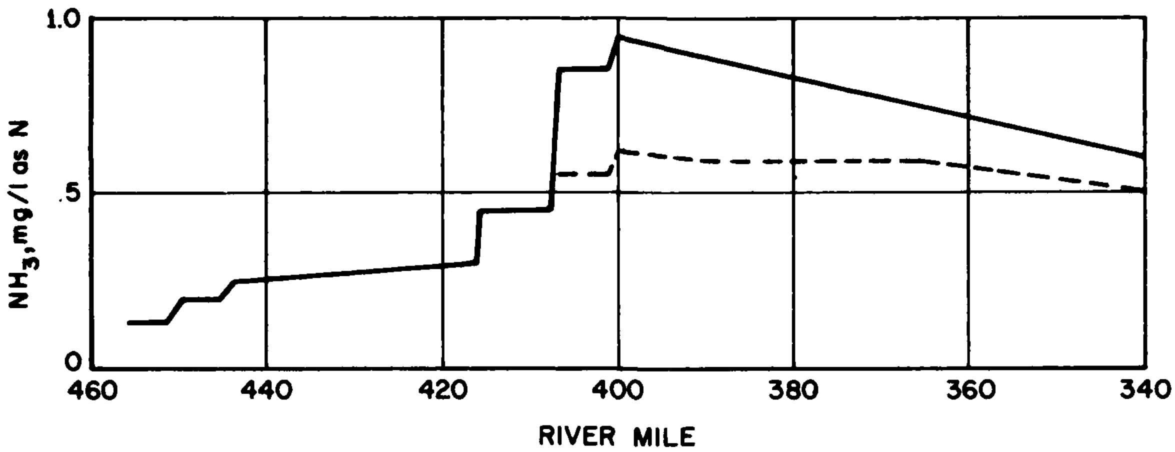
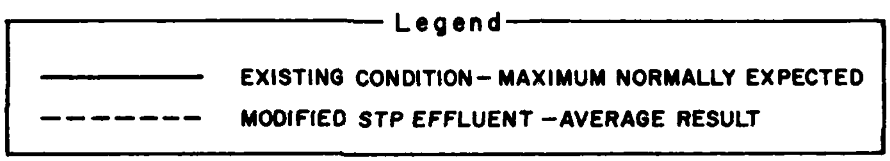


Figure VI-18. IMPACT ON NH_3 DUE TO MODIFIED STP EFFLUENT



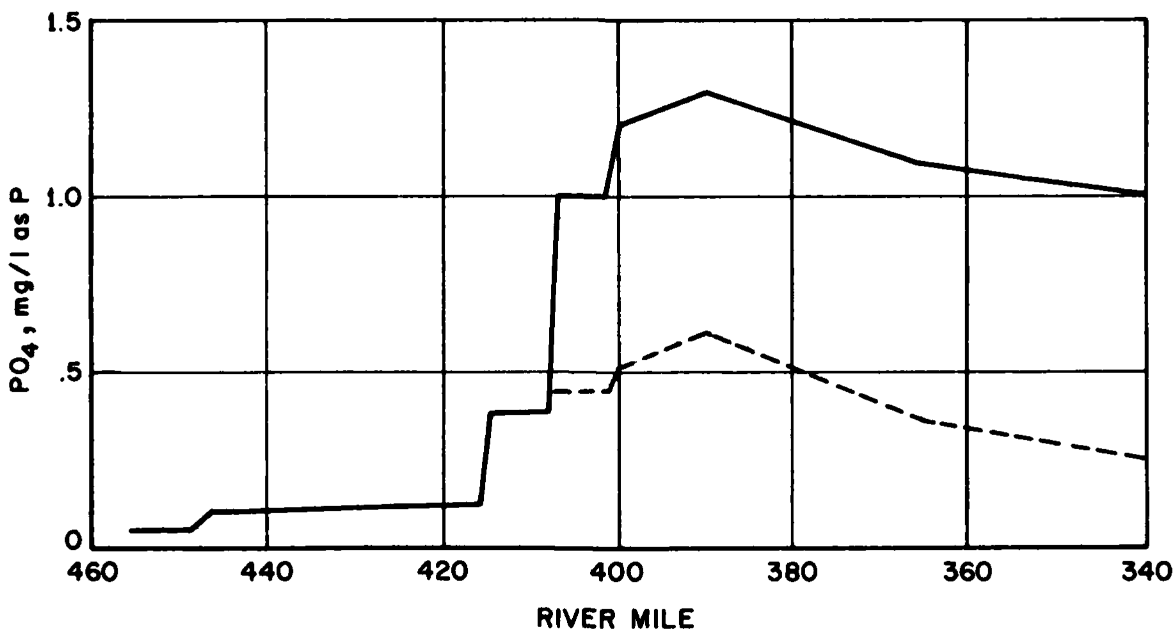


Figure VI-19. IMPACT ON PO_4 DUE TO MODIFIED STP EFFLUENT

significance of the change is viewed in a more appropriate way. Reservoir modeling studies need to be conducted to evaluate the quantitative impact on West Point due to this predicted improvement in the inflow quality.

The general conclusion from examination of figures VI-17 through VI-19 would suggest evaluation of several more advanced levels of treatment and a balancing of their costs against increments of improvements.

VII. SENSITIVITY AND COMPARISON STUDIES

R.M. Clayton Effluent

On the State's records for R.M. Clayton sewage treatment plant effluent, there was a note suggesting significant quantities of unmonitored flow had bypassed the treatment system during the study period. Because the quanity and the quality of the bypassed material were unknown, the Chattahoochee River system was tested for sensitivity of error due to this loading.

The quality of the monitored discharge was modified by increasing the BOD, NH_3 and detritus (i.e., volatile solids). It was assumed that 50 percent of the raw sewage bypassed the treatment system and was a typical sewage os medium strength.

Textbooks (14 and 15) suggest that medium strength raw sewage might have BOD, NH_3 and detritus concentrations of 200, 30 and 250 mg/l respectively. These raw sewage concentrations were evenly weighted with the estimated sewage treated effluent concentrations and the river system was resimulated and compared with the "existing conditions" simulation. The main reason for the comparison was to identify how much of the error in prediction of DO was due to the unknown effluent from the R.M. Clayton plant.

When the comparisons were made, the decrease in DO resulting from the increased loadings was .01 mg/l after 1 mile, .1 mg/l after 8 miles, and .4 mg/l after 18 miles. While these differences are quite significant, they were obviously not the total source of error in the predicted DO as shown in table VI-1.

Atmospheric Turbidity

The WQRRS model has an input coefficient which indexes the atmospheric turbidity or particle density. The coefficient varies from 2 for an unpolluted atmosphere to 5 for a highly polluted atmosphere. The higher this value, the more attenuation in short-wave radiation and therefore less warming of the river water. The higher the atmospheric turbidity, the more heat-

ing potential due to long-wave radiation and therefore more warming of the river water. While the short-wave attenuation and the increased long-wave radiation have opposite effects, the decreased short-wave warming apparently dominates.

In reach I, simulations were made with the atmospheric turbidity equal to 2 and 3. The decrease in stream temperature was as large as .3°C (.54°F). While this is a significant increment, when other sources of potential error (e.g., unknown tributary inflow temperatures) are considered, a stream temperature error of .3°C seems less important.

In the study, an atmospheric turbidity of 2 was used for analysis down to Morgan Falls, 3 was used from Morgan Falls to Camp Creek, and 2 was used again from Camp Creek to Franklin.

DOSAG II Model Comparison

The State of Georgia Environmental Protection Division (EPD) has performed computer modeling studies on this same reach of Chattahoochee River using a steady-state water quality model developed by the Texas Water Development Board and modified by EPD. The model, DOSAG II, predicts DO and BOD with known inputs for the same parameters for a given steady discharge at each inflow location.

A comparison of results between DOSAG II and the WQRRS model (used in a steady flow/steady state mode) was made using the same loading but using different reaeration rates and geometry, for technical reasons. A detailed discussion of the comparison and a graphical display of the results is shown in appendix H.

VIII. REFERENCES

1. "Water Quality for River-Reservoir Systems," Computer Program Description Corps of Engineers, Hydrologic Engineering Center, 1977.

2. "Flood Hydrograph Package - HEC-1," Computer Program Description (Users Manual), Corps of Engineers, Hydrologic Engineering Center, January 1973.

3. "Water Surface Profiles - HEC-2," Computer Program Description (Users Manual), Corps of Engineers, Hydrologic Engineering Center, October 1973.

4. "Geometric Elements from Cross Section Coordinates," Computer Program Description, Corps of Engineers, Hydrologic Engineering Center, October 1974.

5. "Urban Storm Water Runoff - STORM," Computer Program Description, Corps of Engineers, Hydrologic Engineering Center, January 1975.

6. "Flood Plain Information - Chattahoochee River: Buford Dam to Whitesburg, Georgia," Report to the Atlanta Regional Commission, Corps of Engineers, Mobile District, November 1973.

7. "Analysis of the Thermal Characteristics of the Chattahoochee River," by D.H. Evans and John Eric Edinger, Georgia Power Company.

8. "Ecologic Simulation for Aquatic Environments," Final report to Office of Water Resources Research, Drs. Chen and Orlob, Water Resources Engineers, December 1972.

9. "Flow Routing and Water Quality Simulation for River-Reservoir Systems," Computer Program Description (Draft), Corps of Engineers, Hydrologic Engineering Center, Dr. Ian King, Resource Management Associates, June 1975.

10. "Catalog of Information on Water Data," Water Resources Region 03, Parts A, B, and C, U.S. Geological Survey, Office of Water Data Coordination, Edition 1972.

11. "Chlorophyll A Data Report for the Analyses and Data Collection on the Chattahoochee-Flint Rivers," Report to EPA, James H. Duke, Jr., Water Resources Engineers, September 1973.

12. "FY 1973 Annual Report on the Quality of Urban Storm Runoff Entering San Francisco Bay," R.G. Willey and Bill S. Eichert, The Hydrologic Engineering Center, 11 July 1973.

13. "Non Point Pollution Evaluation, Atlanta Urban Area," Black, Crow and Eidness Inc., and Jordan Jones, & Goulding, Inc. May 1975.

14. "Sewerage and Sewage Treatment," H.E. Babbitt and E.R. Baumann, Wiley 1958.

15. "Engineering Management of Water Quality," P.H. McGauhey, McGraw-Hill, 1968.

16. "IBP - Desert Biome Aquatic Program," Wayne G. Minshall, Aquatic Coordinator, Idaho State University, August 1970.

APPENDIX A

DATA SOURCE CONTACTS

AD-A102 033 HYDROLOGIC ENGINEERING CENTER DAVIS CA F/G 13/2
CHATTAHOOCHEE RIVER WATER QUALITY ANALYSIS.(U)
APR 78 R G WILLEY, D HUFF

UNCLASSIFIED NL

2 OF 3
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APPENDIX A - DATA SOURCE CONTACTS

Name	Firm	Phone	Specialty
Dave Callaway	NOAA - Ashville, NC	704-254-0203	Weather Information
John Drago	Mobile Dist., Mobile, AL	205-690-2737	Reservoir Regulation
Jim Duke	WRE, Austin, TX	512-345-6651	Previous WQ Studies
Jim Harris	Mobile Dist., Mobile, AL	205-690-2724	WQ Data
Roy Herwig	Georgia EPD, Atlanta, GA	404-656-4988	Q and WQ Data
Joe Hutton	Mobile Dist., Mobile AL	205-690-2691	Cross-Section Data
Harold Kerkhoff	Gwinnett County, GA	404-476-3311	Gwinnett Intake Q
Larry Lyons	CofE, Atlanta, GA	404-526-4435	General Information
Gary McDonald	Mobile Dist., Mobile, AL	205-690-2734	Q Data
Jim Motz	Georgia Power, Atlanta, GA	404-521-3400	Q and WQ Data
Larry Neal	Georgia EPD, Atlanta, GA	404-656-4988	General Information
Harold Reheis	Georgia EPD, Atlanta, GA	404-656-4708	STP Data
Gary Samples	Cobb County, GA	404-971-1911	Cobb Intake Q Data
Neal Spivey	Atlanta Water Works, GA	404-355-8234	WQ Data
Bill Stokes	USGS, Atlanta, GA	404-526-4858	Q and WQ Data
John Tapp	EPA, Atlanta, GA	404-526-2156	General Information
Max Woods	Dekalb County, GA	404-457-4776	Dekalb Intake Q Data

APPENDIX B

U.S. WEATHER SERVICE METEOROLOGICAL DATA

Table of Contents

PROJECT ORDER	1. ☐ FIXED PRICE ☐ COST REIMBURSEMENT	2. DATE 29 January 1975
(See Reverse Side for Instructions for Issuing Project Order)		

3. ORDERING COMPONENT		4. PROJECT ORDER NO. SPK HEC-75-8
NAME US ARMY ENGINEER DISTRICT, SACRAMENTO CORPS OF ENGINEERS (S-04167)	ADDRESS 650 CAPITOL MALL SACRAMENTO, CALIFORNIA 95814	5. AMENDMENT NO.

6. PERFORMING ESTABLISHMENT		
NAME National Climatic Center ATTN: Dave Callaway	ADDRESS Federal Building Asheville, NC 28801	STATION NUMBER

7. DELIVERY INSTRUCTIONS		
PLACE	DATE	METHOD

8. DESCRIPTION OF WORK TO BE PERFORMED AND OTHER INSTRUCTIONS *(If Additional Space Is Required, Use Supplemental Data Section on Reverse Side Hereof or Attach Additional Sheets)*

Additional Instructions: The amount authorized by this order may not be exceeded without written authorization from the ordering component (Item 3 above). Submit billing on SF 1080 monthly, and cite the order number shown in item 4 above, indicating either a partial or final billing. Receipt of final billing will constitute a termination of this order and an automatic withdrawal of any unused balance.

Transfer of funds is made to pay for the following data as discussed in the telephone call between Dave Callaway and Robert G. Willey on 29 January 1975:

Station	Years
Atlanta Airport	Jan 65 - Dec 74

The tapes should be prepared on 7-track tape in Card Deck 144 format with 10 cards per record at a density of 556.

SAMPLE

9. DATE ORDERED	TYPED NAME AND TITLE OF ORDERING OFFICER	SIGNATURE
29 Jan 75	BILL S. EICHERT, Director, HEC	

10 a. ACCOUNTING CLASSIFICATION	b. AMOUNT
96X4902 Revolving Fund, S04-167, (VW81 2010 000 0000)	$90.00

11. THIS ORDER IS PLACED IN ACCORDANCE WITH THE PROVISIONS OF 41 USC 23, AND DEPARTMENT OF DEFENSE DIRECTIVE 7220.1. WORK TO BE PERFORMED AND MATERIAL TO BE PROCURED PURSUANT TO THIS OFFER ARE PROPERLY CHARGEABLE TO THE APPROPRIATION OR OTHER ACCOUNTS INDICATED ABOVE UNTIL ______________ *(Day - Month - Year)* THE EXPIRATION DATE OF THIS PROJECT ORDER. FUNDS IN THE AMOUNT INDICATED ABOVE HAVE BEEN COMMITTED AND WILL BE OBLIGATED UPON RECEIPT OF ACCEPTANCE COPY.

TYPED NAME AND TITLE OF AUTHORIZING OFFICER	SIGNATURE
H. A. DAMESYN FINANCE AND ACCOUNTING OFFICER (S-04167)	

12. THE ABOVE TERMS AND CONDITIONS ARE SATISFACTORY AND ARE ACCEPTED.

DATE ACCEPTED	TYPED NAME AND TITLE OF ACCEPTING OFFICER	SIGNATURE

INSTRUCTIONS

This form is intended for use by components of military departments in placing project orders with Government-owned and operated establishments within and outside the Department of Defense.

ITEM 1 - Check appropriate box indicating type of project order; i.e., fixed price or cost reimbursement.

ITEM 2 - Date of project order or amendment.

ITEM 3 - Name and address of ordering component.

ITEM 4 - Number assigned to project order by ordering component for control purposes.

ITEM 5 - Number assigned to project order amendment by ordering component for control purposes. Formal amendments shall be numbered consecutively.

ITEM 6 - Name, address, and station number of performing establishment.

ITEM 7 - Instructions for place; date and method of delivery, if applicable. If additional space is required, use Supplemental Data Section below.

ITEM 8 - Full description of work ordered *(this may be incorporated by reference)* and such other instructions as conditions of inspections, shipping, packing and marking, etc. Use Supplemental Data Section or attach additional sheets if necessary. Limitations, if any, applicable to the appropriations or other accounts relevant to this order are shown in the Supplemental Data Section below.

ITEM 9 - Self-explanatory.

ITEM 10 - Insert the complete accounting classifications chargeable and the amount of the project order or amendment.

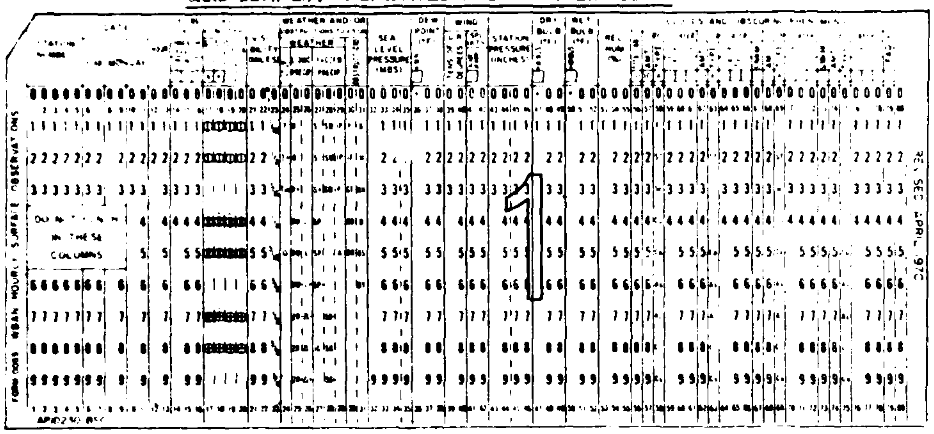
ITEM 11 - Insert in the spaces provided, the expiration date of the project order, the name, title and signature of officer or his authorized representative controlling or having responsibility for the administration of the funds cited on the project order or amendment. If authorizing officer is other than one having fiscal responsibility, the ordering department must have on file as support to the certificate, a written statement by such an officer substantiating the fiscal portion of the certificate.

ITEM 12 - The performing establishment shall indicate acceptance in this space. Duplicate, bearing acceptance date, name, title and signature of accepting officer shall be returned to the ordering component. If the performing establishment is unable to accept the project order, it shall return promptly the original project order form to the ordering office with appropriate explanation.

SUPPLEMENTAL DATA SECTION

U.S. GOVERNMENT PRINTING OFFICE: 1966 O—812636

CARD DECK 144 WBAN HOURLY SURFACE OBSERVATIONS



AREA COVERAGE: United States, Caribbean and Pacific Islands and other overseas stations of U. S. Weather Bureau, Air Force and Navy.

PERIOD OF RECORD: Navy Apr 1945- Weather Bureau Jan 1948- Air Force Jan 1949-
Note: Some prior periods are included in this deck. A status of the period of record for each station is maintained at the National Climatic Center, Asheville, North Carolina.

OBSERVATION TIME: Local Standard Time (LST). For information relating to changes in time of observation, refer to SUPPLEMENTARY NOTE A, page 9. Beginning 1 Jan 65, the Weather Bureau reduced the number of hourly observations punched from 24 to 8 per day. These 3-hourly observations correspond to record observations at 0000, 0300, 0600, 0900, 1200, 1500, 1800, and 2100 GMT. As a result of special studies, some WB stations may have 24 observations per day punched.

CODES: WBAN and WMO

SOURCE: WBAN Forms 10A, 10B and 10 or similar forms. In addition to WBAN Forms for Weather Bureau, Air Force and Navy, those of FAA and Signal Corps are included. Effective 1 Apr 70, forms redesignated as MF 1-10A, 1-10B and 1-10C. MF indicates Meteorological Form.

MISSING DATA: Blanks in appropriate columns are used to indicate missing data. Identification cards were punched for missing observations at AWS stations unless a whole month's record was missing. Punching of ID cards for AWS stations was phased out from Sep-Dec 1968.

COLUMNS AND ELEMENTS PUNCHED: Columns 1-79 are punched.
Elements punched are: (Index on page 14)

Ceiling Height	Rain Showers	Smoke and/or Haze
Sky Condition	Freezing Rain	Dust
Clear	Drizzle	Blowing Snow
Scattered	Freezing Drizzle	Blowing Spray
Broken	Snow	Sea Level Pressure
Overcast	Snow Pellets	Dew Point Temperature
Partial	Ice Crystals	Wind Direction
Obscuration	Snow Showers	Wind Speed
Obscuration	Snow Grains	Station Pressure
Visibility	*Sleet	Dry Bulb Temperature
Weather and/or	Hail	Wet Bulb Temperature
Obstruction to	*Small Hail	Relative Humidity
Vision	Fog	Total Sky Cover
Thunderstorm	Ice Fog	Amount, Type and Height
Tornado	Ground Fog	of Cloud Layers
Squall	Blowing Dust	Opaque Sky Cover
Rain	Blowing Sand	

*Reported as Ice Pellets, effective 1 Apr 70.

ADDITIONAL REMARKS: Card content is generally for recent years. Prior punching or processing procedures are described in "Remarks Column" or in SUPPLEMENTARY NOTES.

Effective 1 Jan 68, the Air Force began the use of the METAR Code at nearly all stations located outside the North American Continent. Observations for these stations are not available on punched cards but on magnetic tape only.

Decks with similar data are listed on page 14.

CORRECTIONS: Any errors detected in this manual should be called to the attention of the Director, National Climatic Center, Environmental Data Service, NOAA; or Chief, Data Processing Division, Environmental Technical Applications Center, USAF. Please give specific instances of error and correct information if available.

CARD CONTENT

COLUMN	ITEM OR ELEMENT	SYMBOLIC LETTER	CARD CODE	CARD CODE DEFINITION	REMARKS
21-79	Missing Data	B	Blank	Unknown	Blank indicates unknown or missing data.
1-5	Station Number WBAN		00001-99999	WBAN Number	A five digit number formulated to designate the station. A list of stations with their coordinates, elevation and period of record is maintained at the NCC in Asheville, N. C.
6-7	Year		00-99	Last two digits of year	
8-9	Month		01-12	01 Jan to 12 Dec	
10-11	Day		01-31	Day of month	
12-13	Hour		00-23	LST	For information relating to time of observation changes and reduction of punches from 24 to 8 observations per day, reference SUPPLEMENTARY NOTE A, page 9 and OBSERVATION TIME, page 1.
14-16	Ceiling Height	hhh	000-990	Hundred of feet 0-99,000 feet	Reporting practices are described in SUPPLEMENTARY NOTE B, page 9.
			XXX	Unlimited	
			888	Cirroform ceiling, height unknown	Effective 1 Sep 56. Punching of 888 for Cirroform ceiling, height unknown, was discontinued on 1 Apr 70.
17-20	Sky Condition				Four column field for up to 4 layers. 0 in unused columns.
17	First Sky Cover Layer	○	0	Clear Cloud cover <.05 Columns 18-20 punched 000	Thin sky cover is a designation given any layer for which the ratio of transparency to total sky cover at that level is ½ or more.
18	Second Sky Cover Layer	–⦶	1	Thin scattered	
19	Third Sky Cover Layer	⦶	2	Scattered Cloud cover .1 thru .5	Prior to September 1956 dark scattered, dark broken, and dark overcast were coded 3, 6, and 9, respectively.
20	Fourth Sky Cover Layer	–⦷	4	Thin broken	
		⦷	5	Broken Cloud cover .6 thru .9	Reporting practices of sky conditions, etc. are described in more detail in SUPPLEMENTARY NOTE C, pages 9-10.
		–⊕	7	Thin overcast Cloud cover 1.0	
		⊕	8	Overcast Cloud cover 1.0 Columns 18-20 punched 000	
		-X	Blank	Partial Obscuration Columns 18-20 punched 0-8 0.1 or more but not all sky hidden by surface based layer	
		X	X	Obscuration All of sky hidden by a surface based layer. Columns 18-20 punched 000.	

CARD CONTENT

COLUMN	ITEM OR ELEMENT	SYMBOLIC LETTER	CARD CODE	CARD CODE DEFINITION	REMARKS
21-23	Visibility	VVV	000-006	0 - 3/8 miles	1/16 mile increments. Refer to Code 3 on page 12.
			006-020	3/8 - 2 miles	1/8 mile increments *
			020-027	2 - 2½ miles	1/4 mile increments. Effective 1 Apr 70, visibilities greater than 7 miles will not be recorded unless a marker is located at a distance greater than 7 miles.
			027-030	2½ - 3 miles	1/2 mile increments
			030-150	3 - 15 miles	1 mile increments
			150-950	15 - 95 miles	5 mile increments
			990	100 miles or more	
				Visibilities reported other than standard punched for next lower value.	*7/8 was not reported prior to Jul 52; and 1 1/8, 1 3/8, 1 5/8 and 1 7/8 until May 53. 1 1/8, 1 3/8, and 1 5/8 were punched as 1, 1¼, and 1½ until Jan 56. 7/8 and 1 7/8 are punched as 3/4 and 1 3/4.
24-31	Weather and/or Obstruction to Vision				See page 8 for intensity definition Columns 24-31.
24			0	None	
	Thunderstorm	T	1	Thunderstorm	
	Heavy/Severe Thunderstorm	T+	2	Heavy thunderstorm/ Severe thunderstorm	See note, page 8, on thunderstorm intensities. Heavy thunderstorm redefined Severe Thunderstorm 1 Jul 68.
	Tornado Waterspout	Tor	3	Tornado - Land Waterspout - Water	
	Squall	Q	5	Squall	Reported as rain or snow squalls (RQ,SQ) before 1949. Intensity reported prior to 1 Jun 51. Definition is given on page 8.
25	Liquid Precipitation		0	None	
		R-	1	Light rain	
		R	2	Moderate rain	
		R+	3	Heavy rain	
		RW-	4	Light rain showers	
		RW	5	Moderate rain showers	
		RW+	6	Heavy rain showers	
		ZR-	7	Light freezing rain	
		ZR	8	Moderate freezing rain	
		ZR+	9	Heavy freezing rain	
26	Liquid Precipitation		0	None	Codes 1, 2 and 3, light, moderate and heavy rain squalls reported prior to 1949. Drizzle intensity explained in SUPPLEMENTARY NOTE D, page 10.
		L-	4	Light drizzle	
		L	5	Moderate drizzle	
		L+	6	Heavy drizzle	
		ZL-	7	Light freezing drizzle	
		ZL	8	Moderate freezing drizzle	
		ZL+	9	Heavy freezing drizzle	

CARD CONTENT

COLUMN	ITEM OR ELEMENT	SYMBOLIC LETTER	CARD CODE	CARD CODE DEFINITION	REMARKS
27	Frozen Precipitation		0	None	
		S-	1	Light snow	
		S	2	Moderate snow	
		S+	3	Heavy snow	
		SP-	4	Light snow pellets	
		SP	5	Moderate snow pellets	
		SP+	6	Heavy snow pellets	Code 7, IC - and code 9, IC +; intensity reported prior to 1 Apr 63
		IC	8	Ice crystals	
28	Frozen Precipitation		0	None	
		SW-	1	Light snow showers	
		SW	2	Moderate snow showers	
		SW+	3	Heavy snow showers	Codes 4. 5 and 6, light, moderate and heavy snow squalls reported prior to 1949.
		SG-	7	Light snow grains	
		SG	8	Moderate snow grains	
		SG+	9	Heavy snow grains	
29	Frozen Precipitation		0	None	Prior to 1 Apr 70 Ice Pellets were coded as Sleet (E-, E, E+). On this date Sleet and Small Hail were redefined as Ice Pellets.
		IP-	1	Light Ice Pellets	Ice Pellet Showers (IPW) are coded as Ice Pellets; Sleet Showers were coded as Sleet.
		IP	2	Moderate Ice Pellets	
		IP+	3	Heavy Ice Pellets	
		A	5	Hail	Hail intensities reported prior to 1 Sep 56: Codes 4, 6, 7, and 9, A-, A+, AP- and AP+.
		AP	8	Small Hail	Deleted 1 Apr 70; redefined as Ice Pellets.
30	Obstructions to Vision		0	None	SUPPLEMENTARY NOTE E, Page 10 explains the reporting practices of these elements.
		F	1	Fog	OBSTRUCTIONS TO VISION are recorded only when the visibility is less than 7 miles.
		IF	2	Ice fog	
		GF	3	Ground fog	
		BD	4	Blowing dust	
		BN	5	Blowing sand	
31	Obstructions to vision		0	None	
		K	1	Smoke	
		H	2	Haze	
		KH	3	Smoke and haze	
		D	4	Dust	
		BS	5	Blowing snow	
		BY	6	Blowing spray	Effective 1 Jul 52.

CARD CONTENT					
COLUMN	ITEM OR ELEMENT	SYMBOLIC LETTER	CARD CODE	CARD CODE DEFINITION	REMARKS
32-35	Sea Level Pressure	PPPP	0000-9999	Millibars and tenths 0000 = 1000.0 mb 9999 = 999.9 mbs.	Thousands digit not punched. Antarctic stations, see SUPPLEMENTARY NOTE H, page 11. AWS punched 3-hourly only effective 1 Jul 58.
36-38	Dew Point Temperature	$T_dT_dT_d$	000-099 X01-X99	0 to 199 Whole degrees F. -1 to -99 X in Column 36 for negative values.	Before 1949, dew point was computed with respect to ice if temperature was below 32°F. Beginning Jan 49, it was computed with respect to water regardless of temperature.
39-40	Wind Direction	dd	00-36	True direction, in tens of degrees, from which wind is blowing (Code 1, page 12 eff. 1 Jan 64)	Prior to 1964, wind directions were reported according to Code 2, page 12. See SUPPLEMENTARY NOTE H, page 11, for punching procedures at Admundsen-Scott Station, Antarctica.
41-42	Wind Speed	ff	00-99 X/	Knots X overpunch in Column 41 indicates 100 or more knots	Prior to Jan 55 in miles per hour at AF and WB stations; in knots at most Navy stations.
43-46	Station Pressure	PPPP	1000-3999	10.00 to 39.99 inches to Hundreds H_g.	Station pressure is the pressure at the assigned station elevation. AWS punched 3-hourly only effective 1 Jul 58, 6-hourly effective 1 Jan 64, and 3-hourly eff. on receipt of order dated 1 Jun 65.
47-49	Dry Bulb Temperature	TTT	000-199	Whole degrees F. 0 to 199	
			X01-X99 $\frac{X}{100}$ - $\frac{X}{199}$	-1 to -99 -100 to -199	Column 47 punched X or X overpunch for values below zero.
50-52	Wet Bulb Temperature		000-199 X01-X99	Whole degrees F. 0 to 199 -1 to -99	Column 50 punched X for minus. AWS began phasing out punching wet bulb data 1 Jul 58. WB and Navy discontinued punching wet bulb data 1 Jan 65. See SUPPLEMENTARY NOTE F, page 10 for hygrothermometer input. For methods of computation of wet bulb temperature and relative humidity, refer to page 13.
53-55	Relative Humidity	RH	000-100	0 to 100 whole percent Cols.	AWS discontinued punching Columns 53-55 1 Jul 58. WB discontinued punching Columns 53-55 1 Jan 65. NWS, effective 1 Apr 70, RH is punched only when entered on Form 1-10B; entry of RH on form is optional. Relative humidity computations respect to ice, etc. reporting practices explained in SUPPLEMENTARY NOTE F, page 10.
56-79	Clouds and Obscuring Phenomena				See SUPPLEMENTARY NOTE G, page 11 for information on cloud layers.
56	Total Sky Cover		0-9 X	Tenths 10 Tenths	

CARD CONTENT					
COLUMN	ITEM OR ELEMENT	SYMBOLIC LETTER	CARD CODE	CARD CODE DEFINITION	REMARKS
57	Amount of Lowest Layer		0-9 X	Tenths 10 Tenths	Weather Bureau stations reported detailed cloud observations(Cols. 56-78) only every 3 hours, based upon the time of synoptic observations, until June 1951 and Jan 1965-present. Only Col. 56, Total Sky Cover, was punched for the intermediate observations. Beginning Jun 51, complete cloud observations were reported and punched (Cols.56-79) for every record obs. as was the practice with Air Force and Navy stations. In all cards of FAA(CAA) stations, Cols. 57-78 are not punched. Note: Air Force stations coverage beginning 1 Jul 58, Cols. 57-79 were reduced from hourly to 3-hourly punching. Except for Korean and down range stations, punching of Cols. 58-61 and 63-79 was discontinued on 1 Jan 64 and Cols. 57 and 62 on 1 Jul 65.
58	Type of Cloud Lowest Layer	 F St Sc Cu Cb As Ac Ci Cs	0 1 2 3 4 5 6 7 8 9	None/clear Fog Stratus Stratocumulus Cumulus Cumulonimbus Altostratus Altocumulus Cirrus Cirrostratus	
		Stfra	X 2	Stratus Fractus	Sf was contraction prior to 1 Apr 70. Fs (Fractostratus) prior to 1 May 61.
		Cufra	X 4	Cumulus Fractus	Cf was contraction prior to 1 Apr 70. Fc (Fractocumulus prior to 1 May 61.
		Cbmam Ns	X 5 X 6	Cumulonimbus mamma Nimbostratus	Cm was contraction prior to 1 Apr 70.
		Accas	X 7	Altocumulus castellanus	Acc was contraction prior to 1 Apr 70.
		Cc	X 9 X	Cirrocumulus Obscuring phenomenon other than fog	
59-61	Height of Lowest Layer		000-990	Hundreds of feet 0 to 99,000 ft.	
			888	Unknown height of a cirroform layer	Effective 1 Sep 56 through 31 Mar 70.
			XXX	Unlimited vertical visibility	Clear, no clouds reported or surface based partial obscuring phenomena (first layer only).
62	Amount of Second Layer		0-9 X	Tenths 10 tenths	
63	Type of Second Layer		0-9 X/	See Column 58	
64-66	Height of Second Layer			See Columns 59-61	

CARD CONTENT

COLUMN	ITEM OR ELEMENT	SYMBOLIC LETTER	CARD CODE	CARD CODE DEFINITION	REMARKS
67	Summation Amount at Second Layer		0-9 X	Tenths 10 tenths	
68	Amount of Third Layer		0-9 X	Tenths 10 tenths	
69	Type of Third Layer		0-9 X/	See Column 58	
70-72	Height of Third Layer			See Columns 59-61	
73	Summation Amount at Third Layer		0-9 X	Tenths 10 tenths	
74	Amount of Fourth Layer		0-9 X	Tenths 10 tenths	
75	Type of Fourth Layer		0-9 X/	See Column 58	
76-78	Height of Fourth Layer			See Columns 59-61	
79	Total Opaque Sky Cover		0-9 X	Tenths 10 tenths	Effective Jun 51. 1 Jun 62 - Opaque Sky Cover was re-defined: Those portions of cloud layers or obscurations which hide the sky and/or higher clouds. Translucent sky cover which hides the sky but through which the sun and moon (not stars) may be dimly visible will be considered as opaque. 1 Apr 70 - Opaque Sky Cover: The amount (to the nearest tenth) of cloud layers or obscuring phenomena (aloft or surface-based) that completely hides all or a portion of the sky and/or higher clouds that may be present.
80	Not used				

METHODS FOR DETERMINING INTENSITY OF WEATHER

THUNDERSTORM

1945 -

THUNDERSTORM - Characterized by occasional or fairly frequent flashes of lightning; weak to loud peals of thunder; rainfall, if any, light or moderate, and rarely heavy; hail, if any, light or moderate; wind not in excess of 40 miles per hour or 35 knots; and no large temperature drop with passage of the storm.

Note: Wind speed changed to knots on 1 Jan 1955.

1 Jul 68 - Redefined. A thunderstorm is a local storm produced by cumulonimbus cloud, and is always accompanied by lightning and thunder, usually with strong gusts of wind, and sometimes with hail. The intensity of a thunderstorm is based on the following characteristics, observed within the previous 15 minutes: Wind gusts less than 50 knots and hail, if any, less than 3/4 inch in diameter.

HEAVY THUNDERSTORM - Characterized by nearly incessant, sharp lightning; loud peals of almost continuous thunder; heavy rain showers; hail of any intensity; wind in excess of 40 mph (35 knots) as the storm passes overhead; and a rapid drop of temperature, as much as 20°F in 5 minutes with the passage of the storm.

1 Jul 68 - Redefined as SEVERE THUNDERSTORM. The intensity is based on the following characteristics, observed within the previous 15 minutes: Wind gusts of 50 knots or greater or hail, 3/4 inch or greater.

GUSTS OF WIND

1945 - 1951

•RAIN SQUALLS, •SNOW SQUALLS, SQUALLS

- Light - Gusts of 24 mph or less (21 knots)
- Moderate - Gusts of 25-39 mph (22-34 knots)
- Heavy - Gusts of 40 mph or more (35 knots)

•Squalls reported separately after 1948.
Intensity of squalls discontinued 1 Jun 51

GUSTS OF WIND (CONTINUED)

1 Jun 51 - A SQUALL is a strong wind that increases suddenly in speed, maintains a peak speed of 19 mph (16 knots) or more over a period of two or more minutes, and decreases in speed; similar fluctuations will occur at succeeding intervals. (reported if occurred within 15 minutes of time of observation)

1 Apr 70 - A SQUALL is a sudden increase of wind speed by at least 16 knots and rising to 22 kts or more and lasting for at least one minute. (reported if occurred within 10 min. of obs)

RATE OF FALL

1945 -

RAIN, RAIN SHOWERS, FREEZING RAIN

Also DRIZZLE (1945-1946), SNOW, SNOW SHOWERS, SNOW PELLETS, when accompanied by other precipitation or obstructions to vision.

- Light - Trace to 0.10 inch per hour; maximum 0.01 inch in six minutes.
- Moderate - 0.11 to 0.30 inch per hour; more than 0.01 to 0.03 inch in six min.
- Heavy - More than 0.30 inch per hour; more than 0.03 inch in six minutes.

When measurement of rate of fall was impracticable, the intensity was determined visually.

Jan 47-May 51, whether alone or not, and after May 51, when accompanied by other precipitation or obstructions to vision.

DRIZZLE, FREEZING DRIZZLE

- Light - Trace to 0.01 inch per hour
- Moderate - More than 0.01 to 0.02 inch/hour
- Heavy - More than 0.02 inch per hour.

RATE OF FALL AND ACCUMULATION

1946 -

HAIL, •SMALL HAIL, •SLEET, •ICE PELLETS

1 Apr 70 - •Sleet and •Small Hail redefined as •Ice Pellets

- Light - Few pellets falling with no appreciable accumulation.
- Moderate - Slow accumulation.
- Heavy - Rapid accumulation.

VISIBILITY PRECIPITATION

SNOW, SNOW SHOWERS, SNOW PELLETS, DRIZZLE, FREEZING DRIZZLE, SNOW GRAINS
(when occurring alone)

- Light - Visibility 5/8 mile or greater
- Moderate - Visibility 5/16 - 1/2 mile, inclusive
- Heavy - Visibility 1/4 mile or less

1945 - For all forms of snow, when occurring alone, intensity was determined by visibility, as shown above. Intensity of drizzle, when occurring alone, was determined by visibility in 1945 -1946 and after May 1951 -

ICE CRYSTALS with an intensity of greater than "very light" will be rarely observed. Above criteria were referred to if needed.

1 Apr 63 - Reporting of intensities of ICE CRYSTALS was discontinued.

HAZE

1945 -

- HAZE - Visibility 6 miles or less, but rarely below 3 miles.
- DAMP HAZE - Visibility 6 miles or less, but rarely as low as 1 1/4 miles. Not reported after 1948.

NOTE: The intensity "Very light" (less than "Light") was not used before June 1951. It is punched as "Light" for all elements.

SUPPLEMENTARY NOTE A: OBSERVATION TIME Columns 12-13
The time punched is that of the record observations, taken within 10 minutes prior to the hour punched (ex. 1355 punched 14). Prior to Jun 57, obs. were taken within 10 minutes prior to the half hour; minutes are disregarded in punching (ex. 0222 punched 02; 1428, 14. All "War Times" and "Standard Meridian Times" were converted to Local Standard Time before punching. For Air Force stations in the United States, the times were punched in accordance with the established time zones. Time entries for Air Force stations outside the United States were edited prior to punching and where necessary converted to the Local Standard Time of the nearest meridian evenly divisible by 15 degrees.

SUPPLEMENTARY NOTE B: CEILING HEIGHT Columns 14-16
Ceiling was recorded in hundreds of feet above the ground to nearest 100 feet up to 5000 feet, to nearest 500 feet up to 10,000 feet, to nearest 1000 feet above that. Before 1949, Air Force stations recorded ceilings up to and including 20,000 feet, above which point the ceiling was classified as unlimited; Weather Bureau and Navy stations recorded ceiling only up to and including 9,500 feet, above which point the ceiling was considered unlimited. Beginning in 1949, ceiling was re-defined to include the vertical visibility into obscuring phenomena not classified as thin, that, in summation with all lower layers, cover 6/10 or more of the sky. Also at that time all limits to height of ceiling were removed, so that unlimited ceiling became simply less than 6/10 sky cover, not including thin obscuration. Then, beginning 1 Jun 51, ceiling heights were no longer established solely on the basis of coverage. The ascribing of ceilings to thin broken or overcast layers was eliminated. A layer became classified as "thin" if the ratio of transparency to total coverage at that level is ½ or more.

SUPPLEMENTARY NOTE C: SKY CONDITIONS Columns 17-20
Jan 1945-Dec 1948: If there is only one cloud symbol, except for low scattered and obscured, Column 17 was punched with appropriate code, Cols. 18-19 with "X" and Col. 20 was left blank. If clouds were high (above 9,500 ft.) Col. 17 was X overpunched. If clouds were low scattered, "0" was punched in Col.17, height in Cols. 18-19, and code in Col. 20. Cols. 18-19 were left blank if height was missing. When two cloud symbols were reported, the higher cloud was punched in Col.17 and the lower in Col. 20. In 1946, obscured

(continued on next page)

TABLE OF SKY CONDITIONS

The table below shows the punching practices in Columns 17-20 for the periods Jan 45 through Dec 48, and Jan 49 through May 51.

SKY CONDITION	REMARKS	1945-1948 17	18	19	20	1949-5/51 17	18	19	20
Clear ○		0	X	X	0	0	X	X	0
Low Scattered ⦶ at 2500 ft		0	2	5	2	0	2	5	2
High Scattered ⦶ /(over 9500 ft)		$\overset{X}{2}$	X	X		0	9	9	2
Hi Sctd Lwr Sctd ⦶/95 ⦶ at 9500 ft		$\overset{X}{2}$	9	5	2	2	9	5	2
Broken at 12000 ft 12 ⦷		5	X	X		0	X	X	5
High Brkn Lwr Brkn ⦷/⦷ Ceiling 5000 ft		$\overset{X}{5}$	X	X	5	5	X	X	5
High Ovc Lwr Sctd at 2500 ft ⊕/⦶		$\overset{X}{8}$	2	5	2	8	2	5	2
High Ovc Lwr Brkn ⊕/⦷		$\overset{X}{8}$	X	X	5	8	X	X	5
Overcast ⊕		8	X	X		0	X	X	8
Ovc Sctd at 3000 ft ⊕ 30 ⦶		8	3	0	2	8	3	0	2
Ovc Brkn at 2500 ft ⊕ 25 ⦷		8	X	X	5	8	X	X	5
Obscured X		0	X	X	X	0	X	X	X
Thin Obscured -X		0	X	X		0	X	X	

SUPPLEMENTARY NOTE C (Continued)

sky was reported only when heavy obstructions to vision and/or heavy precipitation reduced the ceiling to zero and/or the visibility to less than ¼ mile; and when the visibility was ¼ mile or more, a sky symbol was always reported. Effective 1 Jan 47, the symbol "X", for obscured sky, received the same latitude of usage as all other symbols. "X" then represented sky cover of 6/10 or more, obscured by precipitation or obstructions to vision either alone or in combination with lower clouds, and irrespective of higher clouds and ceiling and/or visibility limits. In August 1947, the use of "-X", for thin obscured, was authorized. In 1946 if a layer of scattered clouds above a layer of broken clouds was clearly observable, it was so reported. In 1947 and 1948, symbols corresponding to higher cloud layers indicated the amount of sky covered not only by their respective layers, but by all layers below them. In all years, the presence of few clouds (less than 1/10) was recorded in Remarks.

Jan 49 through May 51: When only one sky symbol was reported it was punched in Col. 20. The use of an "X" overpunch for high (/) layers was discontinued. (/ indicates over 9500 ft). The height of scattered clouds above 9500 ft was punched in Cols. 18-19 as 99.

Effective 1 Jun 51, the reporting of height of low scattered was discontinued, and provision was made to report any number of sky condition symbols, with the height of each. The ceiling layer was not reported separately as before, but was identified by the entry of a ceiling classification letter immediately preceding the height. Sky condition symbols were reported in ascending order of height, and were punched in that order, unless more than four were reported. In that case, the last (highest) symbol was punched in Column 20, and the first three in Columns 17-19, unless the ceiling symbol was thereby excluded. In the latter case, the first two symbols were punched in Columns 17-18, the ceiling symbol in Column 19, and the highest symbol in Column 20. No symbols were reported in Remarks, as was the practice before June 1951.

Sky condition symbols were also re-defined so that obscuring phenomena aloft and clouds were reported in the same manner (i.e., obscuring phenomena aloft were reported by 0, 0, and 0, rather than X and -X). X and -X were used only to indicate the amount of sky hidden by surface-based phenomena. -X was re-defined as partial obscuration (1/10 to less than 10/10 sky hidden). The symbols X and -X unlike 0, 0, and 0, were defined by the amount of the sky hidden by surface-based phenomena, and -X did not indicate the amount of sky covered. The meaning of "thin" was re-defined. If the total opaque cover created by any layer in combination with lower layers was ½ or less of the summation total cover at that level, the layer was classified as thin. Note that the minus sign, when applied to 0, 0, or 0 means "thin"; when applied to X, means "partial".

SUPPLEMENTARY NOTE D: INTENSITY OF DRIZZLE Column 26

In 1946, intensity determined by visibility (as for smoke) only if drizzle occurred alone. When drizzle was accompanied by other forms of precipitation and/or obstructions to vision, its intensity was determined by rate of fall. In 1947, visibility limitations were dropped, and intensity was determined by rate of fall, even though drizzle occurred alone. In June 1951, previous visibility limits were re-instituted. Intensity of freezing drizzle determined in same manner as for drizzle. See page 8 for limits of intensities.

SUPPLEMENTARY NOTE E: OBSTRUCTIONS TO VISION Columns 30-31

Intensity of light, moderate, or heavy were assigned to obstructions to vision, through 1946. Effective Jan 47, the reporting and punching of all intensities of obstructions to vision were discontinued. Prior to 1 Jan 49, the distinction between F and GF was arbitrary, but beginning with that date an objective distinction was established. If the sky was not hidden above an angle of 33° from horizontal (less than 0.6 hidden), the fog was reported as ground fog (GF). Effective 1 Apr 70, Fog (F)-Ground Fog (GF): This hydrometeor is reported as F when it hides more than half (0.5-1.0) of the sky or extends upward into existing cloud layers. Otherwise it is reported as GF.

SUPPLEMENTARY NOTE F: WET BULB TEMP. & RH Columns 50-55

From Aug 60 - Dec 64 at WB stations with a hygrothermometor, wet-bulb temp. was computed and punched at NCC when instrument was operational above -35°F; when non-operational or -35°F and lower, the wet-bulb temp. was punched at the station from values obtained from standby equipment. At stations not equipped with a hygrothermometer, the wet bulb temperature is considered to be the same as the dry bulb temperature whenever the dry bulb temperature is below -35°F. The same value is entered in parenthesis on the WBAN with dew point being computed in

SUPPLEMENTARY NOTE F (Continued)

respect to water and this value punched into WBAN Card. The relative humidity would then be computed by machine, same as for stations equipped with a hygrothermometer.

Prior to Jan 49, relative humidity computed with respect to ice if the dry bulb temperature was less than 32°F. Beginning Jan 49, computed with respect to water, regardless of temperature. Relative humidity machine calculated from 1 Aug 60. RH was not punched for FAA (CAA) stations except in special cases.

SUPPLEMENTARY NOTE G: CLOUD LAYERS Columns 56-79

Provisions are made for punching as many as four layers of clouds and/or obscuring phenomena existing at one time. If more than four layers existed, the data for levels above the fourth were entered in the Remarks portion of WBAN 10B, and were not punched. Their presence is indicated by the entry for total sky cover. Layers were punched in ascending order of elevation. All fields above a layer which prevented observation were left blank. If two or more types of clouds were observed at the same height, only the predominating type was punched, their amounts being combined. For each layer, the amount, type, and height were punched, and for the second and third layer, the summation amount at the level involved was punched, reflecting the total amount of sky covered by that layer and those below it. The summation total is not necessarily the sum of the individual layers.

In addition to the total sky cover, provision was made in Jun 51 for recording and punching the total amount of opaque sky cover, which is the amount of sky hidden by clouds or obscuring phenomena, as distinguished from the total amount of sky cover.

The height of the layers of clouds or obscuring phenomena aloft was recorded in hundreds of feet, and for fully obscuring phenomena based on the ground, the vertical visibility into it was recorded, with no prescribed limit. All heights were recorded to the nearest 100 feet from the surface to 5,000 feet; to the nearest 500 feet between 5,000 and 10,000 feet; and to the nearest 1,000 feet above 10,000 feet. For obscuring phenomena prescribed as "thin", a condition reportable from Aug 47 through May 51, the height of the base was punched, and in the case of thin fog, was always zero. Before Jan 47, obscuration was not reportable as a cloud type.

SUPPLEMENTARY NOTE G (Cont.) Columns 56-79

Some Weather Bureau and Navy cards in this deck were punched from the old type of reporting form (the WBAN 10 with which deck 142 is aligned) and in which five cloud layers were reported with no summation totals. In these cases, the summation total columns were left blank, and the five layers, if reported, were condensed into four.

SUPPLEMENTARY NOTE H: ANTARCTICA STATION NOTES Columns 32-35, 39-40

I. ADMUNDSEN-SCOTT STATION:

1. Wind Direction on all cards was punched according to the following system:

   A. A wind from 0° longitude was punched as N or 360.
   B. A wind from 90° east longitude was punched as E or 090.
   C. A wind from 180° longitude was punched S or 180.
   D. A wind from 90° west longitude was punched W or 270.

2. In place of sea level pressure (Column 32-35) the height of the 700 mb surface in whole meters was punched. This applies to the period 1 Dec 57 through Jan 66. Station pressure in millibars and tenths punched beginning Feb 66.

II. BYRD STATION, ANTARCTICA

1. In place of sea-level pressure (Columns 32-35) the height of the 850 mb surface was punched in whole meters through Jan 66. Station pressure in millibars and tenths punched beginning Feb 66.

III. PLATEAU STATION, ANTARCTICA 12/65-12/68

1. In place of sea-level pressure (Columns 32-35) the height of the 700 mb surface was punched in whole meters through Jan 66. Station pressure in millibars and tenths punched beginning Feb 66.

CODE TABLES

When coding a meteorological report, symbolic letters are replaced by figures, which specify the value or the state of the corresponding element. In some cases, the specification of the symbolic letter (or group of letters) is sufficient to permit a direct transcription into figures (e.g., GG or PPP). In other cases, these figures are obtained by means of a special code table (or code, in short) for each element.

The codes elaborated to this end, as far as they are in world-wide use, are called international meteorological code tables. These same codes are used inversely for decoding observations and thus making available the information contained in them.

Besides the specifications given by the code tables in world-wide use, other sets of code tables are established by the WMO for regional use. Further arbitrary codes have been made necessary by the use of data in card decks which were never encoded into WMO forms.

Only codes pertinent to this card deck are included in the present manual. They appear in the order in which the elements were introduced in the description of the card content. They are numbered consecutively, and if applicable, the corresponding WMO code numbers are shown.

Code 1

(1949 WMO Code 23)
(1960 WMO Code 0877)

dd - True direction, in tens of degrees, from which wind is blowing (or will blow)

Code figure		Code figure	
00	Calm	19	185° - 194°
01	5° - 14°	20	195° - 204°
02	15° - 24°	21	205° - 214°
03	25° - 34°	22	215° - 224°
04	35° - 44°	23	225° - 234°
05	45° - 54°	24	235° - 244°
06	55° - 64°	25	245° - 254°
07	65° - 74°	26	255° - 264°
08	75° - 84°	27	265° - 274°
09	85° - 94°	28	275° - 284°
10	95° - 104°	29	285° - 294°
11	105° - 114°	30	295° - 304°
12	115° - 124°	31	305° - 314°
13	125° - 134°	32	315° - 324°
14	135° - 144°	33	325° - 334°
15	145° - 154°	34	335° - 344°
16	155° - 164°	35	345° - 354°
17	165° - 174°	36	355° - 4°
18	175° - 184°		

Code 2

dd - Wind Direction

Code Figure		
00	Calm	
11	North	349° - 11°
12	North Northeast	12° - 33°
18	North Northwest	327° - 348°
22	Northeast	34° - 56°
32	East Northeast	57° - 78°
33	East	79° - 101°
34	East Southeast	102° - 123°
44	Southeast	124° - 146°
54	South Southeast	147° - 168°
55	South	169° - 191°
56	South Southwest	192° - 213°
66	Southwest	214° - 236°
76	West Southwest	237° - 258°
77	West	259° - 281°
78	West Northwest	282° - 303°
88	Northwest	304° - 326°

Code 3

VVV - Visibility (Statute Miles)

Code	Miles	Code	Miles
000	0	012	1-1/8
001	1/16	014	1-1/4
002	1/8	016	1-3/8
003	3/16	017	1-1/2
004	1/4	018	1-5/8
005	5/16	019	1-3/4
006	3/8	020	2
007	1/2	024	2-1/4
008	5/8	027	2-1/2
009	3/4	030-150	3-15 *1 mile
010	1	150-950	15-95 *5 mile
		990	100 or more

*increments

COMPUTATION OF WET BULB

Dry Bulb zero and above

$TW = T - (.034N - .00072N[N - 1])\ (T + Tdp - 2P + 108)$

If temperature is less than 100°

TW Rounded = TW + .9 if col. 48 is 0, 1, 2
TW + [.9 - .01 (T + .9)] if col. 48 is 3, 4
TW + .4 if col. 48 is 5 through 9

If temperature is 100° or greater:

TW Rounded = TW + .9.

for Dry Bulb temperatures less than zero:

$TW = T - (.034N - .006N^2)\ (.6[T + Tdp] - 2P + 108)$

TW Rounded = TW - .01Tdp

T = dry bulb temperature in °F

TW = wet bulb in °F

Tdp = dew point in °F

$N = \frac{T - Tdp}{10}$

P = Station pressure measured in inches of mercury

In all cases TW should be computed to at least two decimal places prior to applying the rounding factor.

COMPUTATION OF RELATIVE HUMIDITY

$$RH \cong \left(\frac{173 - .1T + Tdp}{173 + .9T}\right)^8$$

Where T = Air Temp. in °F
T_{dp} = Dew Point Temp. in °F

Reference to the above formula may be found in "An Approximation Formula to Compute Relative Humidity from Dry Bulb and Dew Point Temperatures" by Julius F. Bosen, Monthly Weather Review, Vol. 86, No. 12, Dec. 1958, page 486.

OTHER CARD DECKS CONTAINING HOURLY OBSERVATIONS

DECK		GENERAL PERIOD
019	London Airport Hourly Surface	1948-1961
021	USAAF in Great Britain Surface	1942-1946
132	Canadian Hourly Surface Obs.	1946-1951
134	Canadian Hourly Surface Obs.	1951-1953
135	Canadian Hourly Surface Obs.	1950-1967
139	Japanese Airway Obs. Hourly Sfc.	1958-1961
141	WBAN Hourly Surface Obs.	1937-1945
142	WBAN Hourly Surface Obs.	1945-1948
156	British Hourly Obs.	1941-1948
157	Turkish Hourly Surface Obs.	1950-1959
158	German Hourly Obs. GZMO	1955-1961
158	German Hourly Obs. GZMO	1962-1964
159	Korean Hourly Obs. ROK	1954-1964
159	Korean Hourly Obs. ROK	1965-1967
160	Azores Hourly Obs.	1951-1955
171	Nanking Hourly Obs.	1928-1937
172	Yungan Hourly Obs.	1938-1942
175	Taichung Hourly Obs.	1952-1956
928	Hourly Marine Sfc OSV's	1965-1970

ELEMENTS (ITEMS) PUNCHED

	Page		Page
CEILING	2	SKY CONDITION	2
CLOUDS (4 layers) Amount, Type, Height	6	STATION NUMBER	2
Amount Total	5	TEMPERATURE	
Amount Total Opaque	7	Dew Point	5
		Dry Bulb	5
DATE Yr Mo Day Hour	2	Wet Bulb	5
		VISIBILITY	3
HUMIDITY Relative %	5		
PRESSURE		WEATHER AND/OR OBSTRUCTIONS TO VISION	3-4
Sea Level	5		
Station	5	WIND	5

CARD DECK 144 ACRONYMS

AF	Air Force
AWS	Air Weather Service
CAA	Civil Aeronautics Administration (same as FAA)
ESSA	Environmental Science Services Administration (NOAA after 3 Oct 1970)
ETAC	Environmental Technical Applications Center
FAA	Federal Aviation Administration (formerly CAA)
GZMO	German Zonal Meteorological Organization
GMT	Greenwich Mean Time
ID	Identification (cards)
METAR	Meteorological Aviation Routine Weather Report
MF	Meteorological Form
NCC	National Climatic Center (formerly National Weather Records Center (NWRC))
NNWS	NOAA National Weather Service (formerly WB)
NOAA	National Oceanic and Atmospheric Administration (eff. 3 Oct 1970)
NWS	Naval Weather Service
OSV	Ocean Station Vessel
ROK	Republic of Korea
USAF	United States Air Force
WB	Weather Bureau (changed to NNWS 3 Oct 1970)
WBAN	Weather Bureau - Air Force - Navy
WMO	World Meteorological Organization

LOCAL CLIMATOLOGICAL DATA

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

ATLANTA, GEORGIA
NAT WEATHER SERVICE FCST OFC
HARTSFIELD ATLANTA INTL AP
AUGUST 1974

LATITUDE 33° 39′ N LONGITUDE 84° 26′ W ELEVATION (GROUND) 1010 FT. STANDARD TIME USED: EASTERN WBAN #13874

Date	Temperature °F: Maximum	Minimum	Average	Departure from normal	Average dew point	Degree days base 65°: Heating	Cooling	Weather types on dates of occurrence (1 Fog; 2 Heavy fog X; 3 Thunderstorm; 4 Ice pellets; 5 Hail; 6 Glaze; 7 Duststorm; 8 Smoke, haze; 9 Blowing snow)	Snow, ice pellets or ice on ground at 07AM In.	Precipitation: Water equivalent In.	Snow, ice pellets In.	Avg. station pressure In. Elev. 1034 feet m.s.l.	Wind: Resultant direction	Resultant speed M.P.H.	Average speed M.P.H.	Fastest mile: Speed M.P.H.	Direction	Sunshine: Hours and tenths	Percent of possible	Sky cover tenths: Sunrise to sunset	Midnight to midnight	Date
1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	88	68	78	0	64	0	13	3 8	0	.47	0	28.98	09	1.8	6.8	27	N	8.8	64	6	6	1
2	84	68	76	-2	68	0	11	1	0	.06	0	28.95	17	4.4	6.3	16	SE	4.5	33	8	8	2
3	81	70	76	-2	69	0	11	1 3	0	.36	0	28.98	18	0.4	8.8	16	S	0.6	4	10	10	3
4	83	69	76	-2	69	0	11	1 3	0	T	0	28.97	21	5.5	6.2	11	S	6.4	47	7	8	4
5	80	68	74	-4	68	0	9	1 3 8	0	T	0	28.93	10	2.3	5.5	11	SE	2.6	19	8	10	5
6	82	67	75	-3	67	0	10		0	0	0	28.96	14	6.7	7.5	19	E	5.3	38	7	7	6
7	73	68	71*	-7	68	0	6	1 3	0	1.26	0	29.05	10	9.2	8.4	17	S	0.0	0	10	10	7
8	78	68	73	-5	69	0	8	1	0	.06	0	29.07	14	3.0	4.8	9	SE	0.9	7	10	10	8
9	84	70	77	-1	70	0	12	1	0	.57	0	29.00	27	1.8	4.0	10	W	4.3	32	8	8	9
10	87	68	78	0	69	0	13		0	T	0	28.97	30	5.3	8.6	14	W	11.0	81	5	5	10
11	85	70	78	0	70	0	13	1 3 8	0	.87	0	29.06	10	8.5	9.8	18	SE	5.2	38	8	8	11
12	82	68	75	-3	69	0	10	1 8	0	T	0	29.05	23	1.9	4.8	10	W	3.4	25	10	7	12
13	86	66*	76	-2	68	0	11	2 8	0	T	0	28.97	28	3.4	4.8	11	W	7.8	58	5	4	13
14	81	67	74	-4	69	0	9	1 3 8	0	.79	0	28.98	08	2.7	5.8	23	W	1.8	13	8	8	14
15	85	68	77	-1	69	0	12	1	0	0	0	29.05	18	2.0	4.8	10	S	4.8	36	8	8	15
16	85	69	77	-1	70	0	12	1 3	0	.15	0	29.07	18	1.5	5.8	9	N	5.4	40	7	7	16
17	88	70	79	1	70	0	14	1	0	0	0	28.96	29	6.0	7.6	12	W	6.9	52	4	4	17
18	86	69	78	0	69	0	13	3	0	.20	0	28.88	25	1.7	4.8	29	N	3.3	25	8	6	18
19	88	67	78	0	67	0	13	1	0	0	0	28.91	32	4.2	5.0	8	NW	13.3	100	3	3	19
20	83	69	76	-2	66	0	11	8	0	0	0	28.99	08	9.0	8.8	17	E	13.3	100	8	3	20
21	83	68	76	-1	66	0	11	1 8	0	0	0	29.06	08	9.8	10.4	17	E	6.5	48	6	4	21
22	85	67	76	-1	65	0	11	8	0	0	0	29.07	09	8.2	7.1	10	E	8.0	61	4	4	22
23	86	69	78	1	66	0	13	1	0	0	0	29.04	06	5.5	6.8	11	NE	9.8	72	3	2	23
24	87	68	78	1	66	0	13	8	0	0	0	29.02	04	1.8	3.7	8	NW	12.4	95	2	1	24
25	88	70	79	2	68	0	14	8	0	0	0	29.02	20	2.1	3.2	7	S	9.9	76	4	3	25
26	89	69	79	2	68	0	14	8	0	0	0	29.01	17	.9	2.3	10	W	12.0	92	4	2	26
27	91	70	81	4	69	0	16	8	0	0	0	28.99	26	2.6	5.2	8	S	10.0	77	5	5	27
28	91*	71	81*	5	70	0	16	8	0	0	0	28.96	24	4.6	5.2	12	SW	12.0	92	6	6	28
29	85	69	77	1	70	0	12	3	0	.81	0	28.98	24	4.1	6.2	17	W	6.1	47	9	8	29
30	87	69	78	2	69	0	13	1 3	0	.06	0	29.01	24	5.8	6.8	24	S	7.6	58	7	8	30
31	86	70	78	2	68	0	13	1 3	0	.84	0	28.98	26	4.1	5.5	18	SW	7.5	58	8	8	31
	SUM 2627	SUM 2127				TOTAL 0	TOTAL 368	NUMBER OF DAYS		TOTAL 6.26	TOTAL 0	FOR THE MONTH: 29.00	18	1.2	6.2	29	N	TOTAL 211.0	% FOR MONTH 51	SUM 208	SUM 197	
	AVG. 84.7	AVG. 68.6	AVG. 76.7	DEP. -0.8	AVG. 68	DEP. 0	DEP. -20	PRECIPITATION ≥ .01 INCH 13		DEP. 2.72							DATE: 18	POSSIBLE 414.6		AVG. 6.7	AVG. 6.4	

NUMBER OF DAYS: MAXIMUM TEMP. ≥ 90°	MAXIMUM TEMP. ≤ 32°	MINIMUM TEMP. ≤ 32°	MINIMUM TEMP. ≤ 0°	SEASON TO DATE: HEATING TOTAL	COOLING TOTAL
2	0	0	0	0	1267
				DEP. 0	DEP. -38

NUMBER OF DAYS	
SNOW, ICE PELLETS ≥ 1.0 INCH	0
THUNDERSTORMS	12
HEAVY FOG X	1
CLEAR 3 PARTLY CLOUDY 15 CLOUDY 13	

GREATEST IN 24 HOURS AND DATES: PRECIPITATION		SNOW, ICE PELLETS	GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE
1.31	7- 8	0	0

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

Date	A.M. hour ending at 1	2	3	4	5	6	7	8	9	10	11	12	P.M. hour ending at 1	2	3	4	5	6	7	8	9	10	11	12	Date
1																				.18	.26	.03	T		1
2						T	T							T						.04	.02	T	T		2
3		T		T	T	T	.02					.02	.10	.13	.06	.02	.01		T	T	T				3
4			T	T																					4
5												T	T	T							T	T			5
6																									6
7						T	T	.03	T	.15			T	.02	.70	.02	.18	.08	.02	.03	T	.01	T	.01	7
8	.01	.04	T	T	T			T	.01				T						T	T	T				8
9					.05	.02	.05	.34	.11	T	T														9
10														T	T										10
11			.03	T															.04	.08	.28	.44	T		11
12									T	T	T														12
13														T											13
14												.50	.20	.05	T										14
15																									15
16													.12	T		T						T	.03		16
17																									17
18														T	.20										18
19																									19
20																									20
21																									21
22																									22
23																									23
24																									24
25																									25
26																									26
27																									27
28																									28
29																		.16	.06	T	.02	T		.57	29
30	.03	.02	T	T	T	T															T	.01			30
31				T	T	T														.80	.04	T			31

* EXTREME TEMPERATURES FOR THE MONTH. MAY BE THE LAST OF MORE THAN ONE OCCURRENCE.
- BELOW ZERO TEMPERATURE OR NEGATIVE DEPARTURE FROM NORMAL.
≥ 70° AT ALASKAN STATIONS.
* ALSO ON AN EARLIER DATE, OR DATES.
X HEAVY FOG RESTRICTS VISIBILITY TO 1/4 MILE OR LESS.
T IN THE HOURLY PRECIPITATION TABLE AND IN COLUMNS 9, 10, AND 11 INDICATES AN AMOUNT TOO SMALL TO MEASURE.
THE SEASON FOR DEGREE DAYS BEGINS WITH JULY FOR HEATING AND JANUARY FOR COOLING.
DATA IN COLUMNS 6, 12, 13, 14, AND 15 ARE BASED ON 8 OBSERVATIONS PER DAY AT 3-HOUR INTERVALS.
WIND DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. RESULTANT WIND IS THE VECTOR SUM OF WIND DIRECTIONS AND SPEEDS DIVIDED BY THE NUMBER OF OBSERVATIONS. FIGURES FOR DIRECTIONS ARE TENS OF DEGREES FROM TRUE NORTH; I.E., 09=EAST, 18=SOUTH, 27=WEST, 36=NORTH, AND 00=CALM. WHEN DIRECTIONS ARE IN TENS OF DEGREES IN COL. 17, ENTRIES IN COL. 16 ARE FASTEST OBSERVED 1-MINUTE SPEEDS. IF THE / APPEARS IN COL. 17, SPEEDS ARE GUSTS.
ANY ERRORS DETECTED WILL BE CORRECTED AND CHANGES IN SUMMARY DATA WILL BE ANNOTATED IN THE ANNUAL SUMMARY.

SUBSCRIPTION PRICE: LOCAL CLIMATOLOGICAL DATA $2.00 PER YEAR INCLUDING ANNUAL ISSUE IF PUBLISHED. FOREIGN MAILING 75¢ EXTRA. SINGLE COPY: 20¢ FOR MONTHLY ISSUE; 15¢ FOR ANNUAL SUMMARY. MAKE CHECKS PAYABLE TO DEPARTMENT OF COMMERCE, NOAA. SEND PAYMENTS AND ORDERS TO NATIONAL CLIMATIC CENTER, FEDERAL BUILDING, ASHEVILLE, NORTH CAROLINA 28801.

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA, 28801

William H. Haggard

DIRECTOR, NATIONAL CLIMATIC CENTER

SUMMARY BY HOURS

Hour local time	Averages: Sky cover tenths	Station pressure in.	Temperature: Air °F	Wet bulb °F	Dew pt. °F	Relative humidity %	Wind speed M.P.H.	Resultant wind: Direction	Speed M.P.H.
01	6	29.00	72	68	68	88	6.3	14	1.4
04	6	28.98	70	68	67	91	4.8	10	1.7
07	6	29.01	70	68	68	92	5.8	08	1.4
10	6	29.04	77	72	68	77	6.6	18	1.8
13	7	29.01	81	72	68	66	7.2	22	1.9
16	7	28.96	83	72	68	63	7.3	17	2.1
19	7	28.97	78	72	68	72	6.8	13	1.3
22	8	29.01	74	70	68	84	6.0	15	1.3

USCOMM - NOAA - ASHEVILLE 829
9/19/74

ATLANTA, GEORGIA

OBSERVATIONS AT 3-HOUR INTERVALS

Day	Hour	Sky cover (tenths)	Ceiling (hundreds of ft.)	Visibility (miles)	Weather	Air °F	Wet bulb °F	Dew pt. °F	Rel. hum. %	Wind dir.	Wind speed knots
DAY 01	01	1	UNL	12		71	64	58	66	31	4
	04	0	UNL	12		70	64	61	73	36	4
	07	10	200	7		72	67	64	76	36	5
	10	3	UNL	7		80	72	68	67	13	6
	13	5	UNL	6	RW	85	73	67	55	14	5
	16	5	UNL	7		87	73	67	52	11	6
	19	8	60	7		80	68	63	56	08	10
	22	10	36	7	RW	68	66	65	90	26	7
DAY 02	01	10	50	7		68	67	66	90	13	7
	04	10	50	7		68	67	66	90	12	6
	07	10	40	2 8	GF	68	68	67	93	12	6
	10	8	100	7		75	72	70	88	10	6
	13	8	30	12		81	72	67	63	00	8
	16	8	300	12		82	72	68	63	17	7
	19	10	250	12		78	72	70	77	23	7
	22	10	16	8	R	72	70	68	88	22	6
DAY 03	01	10	9	10		74	71	70	93	20	8
	04	10	10	12		71	70	68	93	17	7
	07	10	4	10		72	71	70	93	18	7
	10	10	14	12		76	73	70	82	20	11
	13	10	20	10	RW	74	72	71	90	18	10
	16	10	26	8	R	71	68	68	90	18	10
	19	10	40	6	R	71	70	68	90	18	10
	22	10	4	7		71	70	68	87	13	6
DAY 04	01	10	2	6	F	70	68	68	87	18	4
	04	10	2	6	F	71	70	68	93	17	5
	07	10	100	8		70	68	68	87	22	5
	10	8	10	10		76	71	68	78	22	6
	13	6	100	12		80	72	68	66	24	6
	16	8	36	12		82	72	68	63	18	6
	19	5	UNL	12		78	71	68	71	29	6
	22	8	46	12		74	70	68	82	00	0
DAY 05	01	10	250	12		71	70	68	93	00	0
	04	10	100	10		68	68	67	93	20	3
	07	10	2	1 8	FH	68	68	68	100	02	5
	10	8	60	5	H	70	72	68	74	04	7
	13	8	250	6	TRWH	74	71	68	84	16	6
	16	8	250	6	H	80	71	68	62	06	6
	19	10	50	6	H	77	70	67	71	12	7
	22	10	50	12		73	70	68	84	10	4
DAY 06	01	10	8	12		70	68	67	90	13	6
	04	10	100	12		70	67	66	93	17	4
	07	8	5	8		68	67	67	97	12	5
	10	10	15	10		72	68	67	84	12	6
	13	8	30	12		79	70	66	67	21	6
	16	4	UNL	12		81	72	67	63	14	7
	19	3	UNL	12		76	70	61	74	12	11
	22	5	UNL	12		73	68	67	82	13	8
DAY 07	01	10	20	12		71	68	68	90	10	7
	04	10	3	12		70	68	68	93	08	9
	07	10	5	10		68	68	67	93	08	12
	10	10	6	7		70	68	68	93	10	8
	13	10	12	7	R	72	70	68	90	10	8
	16	10	40	6	RF	73	71	70	90	08	7
	19	10	70	6	RF	70	68	68	93	12	7
	22	10	80	6	RF	68	68	68	97	10	7
DAY 08	01	10	3	8	R	68	67	67	97	13	6
	04	10	3	10		68	68	68	100	13	6
	07	10	1	0 4	F	68	68	68	100	13	6
	10	10	2	1 8	F	71	70	68	93	13	6
	13	10	15	8		75	72	70	88	16	4
	16	10	100	12		78	72	68	74	20	5
	19	10	100	10		76	72	68	85	20	3
	22	10	100	6	R	74	71	70	87	00	0
DAY 09	01	10	100	12		72	71	70	93	08	4
	04	10	40	12		71	71	70	97	10	3
	07	10	7	2	RF	72	71	70	93	00	0
	10	10	4	4	RF	71	70	70	97	26	5
	13	10	30	6		76	73	70	74	27	4
	16	8	300	10		82	72	68	63	23	3
	19	8	300	10		78	73	70	74	30	4
	22	8	250	10		76	71	68	78	28	5
DAY 10	01	3	UNL	8		72	71	70	93	32	5
	04	0	UNL	8		68	68	67	93	32	6
	07	1	UNL	7		68	68	67	93	30	7
	10	2	UNL	12		82	73	68	65	30	6
	13	8	36	12		85	74	68	58	25	10
	16	3	UNL	10		85	75	70	60	27	8
	19	8	250	8		81	75	73	77	30	8
	22	10	250	12		78	72	68	74	08	10
DAY 11	01	8	40	10		73	71	70	90	09	8
	04	10	5	5		72	71	70	93	09	11
	07	10	8	4	F	72	70	68	90	10	10
	10	10	12	3	H	74	71	68	84	12	7
	13	8	25	6	H	78	73	70	74	09	6
	16	4	UNL	6	H	83	75	71	67	12	11
	19	10	30	3	RWF	78	74	72	79	08	6
	22	10	26	6	RW	71	70	70	97	09	11
DAY 12	01	5	UNL	7		70	68	68	93	10	7
	04	3	UNL	5	GF	68	68	68	97	00	0
	07	10	15	2	F	70	68	68	97	13	3
	10	10	5	2	LF	72	71	70	93	22	4
	13	8	25	6	H	80	72	68	68	22	4
	16	10	300	6	H	78	73	70	74	28	4
	19	10	UNL	6	H	78	73	71	86	27	5
	22	0	UNL	12	H	70	68	68	93	27	6
DAY 13	01	1	UNL	10		70	68	68	93	27	7
	04	0	UNL	7		68	68	67	93	04	4
	07	3	UNL	1 8	FK	67	67	67	100	00	0
	10	4	UNL	5	K	75	72	71	87	22	6
	13	4	UNL	7		84	74	68	61	28	6
	16	5	UNL	7		86	72	66	51	33	6
	19	6	UNL	8		81	72	67	63	28	3
	22	6	300	12		76	72	70	82	00	0
DAY 14	01	1	UNL	10		74	71	68	84	00	0
	04	4	UNL	10		71	70	68	93	07	6
	07	10	120	3	GFH	72	70	68	90	08	5
	10	8	120	5	H	78	73	71	78	10	5
	13	10	12	4	RW	67	66	66	96	33	10
	16	7	120	7		77	72	68	76	11	5
	19	10	UNL	8		75	71	68	79	13	4
	22	5	UNL	12		70	68	68	93	14	4
DAY 15	01	10	100	8		72	70	68	90	15	4
	04	7	300	12		68	68	67	93	00	0
	07	8	300	6	GF	70	68	68	93	00	0
	10	8	300	6		76	72	68	74	01	5
	13	8	37	7		83	73	68	61	13	5
	16	10	250	8		85	75	70	61	16	7
	19	10	250	10		78	74	72	78	22	7
	22	10	250	10		76	73	71	85	27	6
DAY 16	01	8	100	12		73	70	68	87	00	0
	04	8	32	12		71	70	68	93	13	6
	07	3	UNL	5	GF	70	68	68	93	24	3
	10	8	120	8		78	73	70	74	23	4
	13	10	50	8	RW	77	72	70	78	18	7
	16	8	40	12		83	74	70	66	23	6
	19	7	30W	10		80	75	73	80	30	8
	22	7	30	12	T	76	73	72	87	30	8
DAY 17	01	8	UNL	8		72	70	68	88	17	5
	04	8	2	1 8	F	71	70	68	93	22	3
	07	3	UNL	4	GF	71	70	68	93	30	7
	10	3	UNL	7		80	74	72	77	28	8
	13	4	UNL	5		86	74	70	57	32	8
	16	4	UNL	12		87	74	70	56	30	8
	19	1	UNL	12		83	73	68	63	27	8
	22	1	UNL	10		75	72	71	87	30	7
DAY 18	01	0	UNL	10		74	71	70	87	30	5
	04	10	250	7		71	68	68	90	31	5
	07	10	250	7		73	70	68	87	30	5
	10	10	140	7		78	73	70	74	27	5
	13	10	34	10		85	76	72	65	10	4
	16	10	70	10		72	68	68	87	18	6
	19	8	250	10		73	68	67	84	00	0
	22	3	UNL	10		70	68	67	90	18	4
DAY 19	01	6	UNL	10		68	67	66	90	26	5
	04	3	UNL	10		67	66	66	97	27	4
	07	3	UNL	8	GF	68	68	67	97	00	0
	10	3	UNL	7		80	73	70	72	00	0
	13	5	UNL	10		85	72	66	53	35	6
	16	4	UNL	10		87	73	67	52	33	7
	19	2	UNL	10		83	71	66	57	34	7
	22	2	UNL	12		78	70	66	67	34	6
DAY 20	01	0	UNL	10		73	68	67	82	33	4
	04	0	UNL	10		70	68	64	81	07	6
	07	1	UNL	7	H	68	68	66	87	08	10
	10	8	35	8	H	75	70	68	78	08	10
	13	4	UNL	5	H	81	72	67	63	08	10
	16	5	UNL	8	H	83	71	65	55	08	11
	19	1	UNL	6	H	78	71	67	68	07	8
	22	1	UNL	7		73	68	67	82	10	10
DAY 21	01	3	UNL	7		72	68	66	82	08	10
	04	0	UNL	7		68	68	65	87	07	7
	07	10	7	2 8	FH	68	68	66	87	06	10
	10	10	13	2	KH	72	68	66	82	08	8
	13	6	23	6	KH	80	71	66	62	08	8
	16	4	UNL	8		82	71	66	58	12	8
	19	2	UNL	12		78	70	66	65	10	10
	22	4	UNL	12		73	68	66	78	08	10
DAY 22	01	2	UNL	8		68	66	65	90	10	5
	04	8	10	7		68	66	64	84	06	6
	07	0	UNL	5	H	68	65	63	84	06	7
	10	0	UNL	6	H	76	70	67	74	08	6
	13	8	37	7		82	71	66	56	15	7
	16	8	45	8		82	70	64	55	07	6
	19	7	250	7		80	71	66	62	10	6
	22	3	UNL	7		75	70	67	76	08	6
DAY 23	01	3	UNL	7		72	68	67	84	08	6
	04	0	UNL	7		70	67	66	87	08	4
	07	0	UNL	4	GF	70	67	66	87	06	4
	10	2	UNL	7		78	71	67	67	07	8
	13	5	UNL	7		84	71	66	53	04	7
	16	2	UNL	7		84	71	64	51	05	4
	19	8	250	12		82	70	64	55	05	7
	22	0	UNL	10		75	68	66	74	00	0
DAY 24	01	0	UNL	8		73	68	67	82	06	3
	04	0	UNL	7		71	68	66	84	08	5
	07	0	UNL	6	KH	72	68	66	82	36	4
	10	0	UNL	7		81	70	65	58	00	0
	13	4	UNL	10		86	71	64	48	32	7
	16	3	UNL	10		86	71	63	46	15	3
	19	1	UNL	8		82	70	64	55	08	4
	22	0	UNL	8		77	72	68	78	00	0
DAY 25	01	3	UNL	6	RW	73	70	68	84	00	0
	04	0	UNL	5	RW	72	68	68	87	00	0
	07	0	UNL	6	RW	70	68	67	90	00	4
	10	0	UNL	7		82	74	70	67	20	5
	13	8	40	10		86	74	68	55	22	5
	16	6	45	12		86	72	65	50	18	5
	19	1	UNL	10		80	72	68	68	20	3
	22	0	UNL	10		77	70	67	71	00	0
DAY 26	01	0	UNL	10		74	68	67	78	00	0
	04	0	UNL	10		71	68	66	84	00	0
	07	1	UNL	6	RW	71	68	66	84	00	0
	10	4	UNL	6	RW	83	72	67	58	22	5
	13	8	UNL	7		87	74	68	53	00	0
	16	5	UNL	8		88	74	67	50	01	3
	19	3	UNL	7		83	73	68	61	12	6
	22	0	UNL	8		78	73	71	78	10	3
DAY 27	01	4	UNL	8		75	70	67	76	29	5
	04	3	UNL	8		72	69	68	87	00	0
	07	5	UNL	5	RW	71	70	68	93	28	6
	10	0	UNL	7		83	74	70	65	30	3
	13	6	40	7		88	75	70	55	25	7
	16	3	UNL	10		88	74	68	50	22	6
	19	10	250	10		82	74	70	67	02	5
	22	8	250	10		78	72	70	77	12	4
DAY 28	01	7	250	10		74	71	70	87	21	4
	04	7	UNL	10		72	71	70	93	28	5
	07	5	UNL	8	RW	72	71	70	93	00	0
	10	9	150	10		82	75	73	72	30	5
	13	5	UNL	12		88	75	70	55	22	5
	16	5	UNL	12		88	74	68	52	24	8
	19	7	UNL	12		82	74	70	67	23	5
	22	8	UNL	12		77	72	70	78	24	4
DAY 29	01	10	UNL	12		73	70	68	87	25	6
	04	10	120	12		72	71	70	93	23	5
	07	10	140	7		73	71	70	90	26	6
	10	9	140	12		81	74	71	72	23	6
	13	8	140	12	T	83	75	72	70	22	7
	16	10	180	12		83	75	71	67	24	3
	19	10	250	12	TRW	73	70	68	87	02	6
	22	10	140	12		71	68	68	90	17	4
DAY 30	01	10	20	8	RW	70	68	67	90	01	3
	04	10	30	7	R	68	68	66	97	22	5
	07	8	5	4	F	68	68	68	97	23	6
	10	3	UNL	7		77	72	70	78	25	6
	13	8	30	12		83	74	70	65	25	7
	16	8	30	12		87	75	70	57	20	7
	19	8	UNL	12		81	74	71	72	23	5
	22	8	70	10		73	70	68	87	24	8
DAY 31	01	8	70	10		71	70	68	93	24	5
	04	10	70	7	R	70	68	68	93	00	0
	07	10	3	4	F	70	68	68	93	24	4
	10	8	100	8		75	72	70	85	22	5
	13	4	UNL	12		84	73	68	58	32	5
	16	8	250	12		84	72	67	57	32	7
	19	8	250	12		78	72	68	72	22	5
	22	10	140	12		71	68	67	87	24	7

NOTES

CEILING COLUMN:
UNL INDICATES AN UNLIMITED CEILING

WEATHER COLUMN:

- + TORNADO
- T THUNDERSTORM
- Q SQUALL
- R RAIN
- RW RAIN SHOWERS
- ZR FREEZING RAIN
- L DRIZZLE
- ZL FREEZING DRIZZLE
- S SNOW
- SP SNOW PELLETS
- IC ICE CRYSTALS
- SW SNOW SHOWERS
- SG SNOW GRAINS
- IP ICE PELLETS
- A HAIL
- F FOG
- IF ICE FOG
- GF GROUND FOG
- BD BLOWING DUST
- BN BLOWING SAND
- BS BLOWING SNOW
- BY BLOWING SPRAY
- K SMOKE
- H HAZE
- D DUST

WIND COLUMNS:

DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. INDICATED IN TENS OF DEGREES FROM TRUE NORTH: I.E., 09 FOR EAST, 18 FOR SOUTH, 27 FOR WEST. ENTRY OF 00 IN THE DIRECTION COLUMN INDICATES CALM.

SPEED IS EXPRESSED IN KNOTS; MULTIPLY BY 1.15 TO CONVERT TO MILES PER HOUR.

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STATION: ATLANTA GA YEAR & MONTH: 74 08

U.S. DEPARTMENT OF COMMERCE
NATIONAL CLIMATIC CENTER
FEDERAL BUILDING
ASHEVILLE, N.C. 28801

LOCAL CLIMATOLOGICAL DATA

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

ATLANTA, GEORGIA
NAT WEATHER SERVICE FCST OFC
HARTSFIELD ATLANTA INTL AP
SEPTEMBER 1974

LATITUDE 33° 39′ N   LONGITUDE 84° 26′ W   ELEVATION (GROUND) 1010 FT.   STANDARD TIME USED: EASTERN   WBAN #13874

Date	Temperature °F: Maximum	Minimum	Average	Departure from normal	Average dew point	Degree days base 65°: Heating	Cooling	Weather types on dates of occurrence (1 Fog, 2 Heavy fog X, 3 Thunderstorm, 4 Ice pellets, 5 Hail, 6 Glaze, 7 Duststorm, 8 Smoke, haze, 9 Blowing snow)	Snow, ice pellets or ice on ground at 07AM in.	Precipitation: Water equivalent in.	Snow, ice pellets in.	Avg. station pressure in. Elev. 1034 feet m.s.l.	Wind: Resultant direction	Resultant speed m.p.h.	Average speed m.p.h.	Fastest mile: Speed m.p.h.	Direction	Sunshine: Hours and tenths	Percent of possible	Sky cover tenths: Sunrise to sunset	Midnight to midnight	Date
1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	85	70	78	2	69	0	13	3	0	.19	0	28.94	26	6.5	7.3	18	W	5.7	44	8	9	1
2	85	66	76	0	68	0	11	3	0	.30	0	28.89	20	3.6	5.6	14	S	8.3	65	6	7	2
3	77	63	70	-5	65	0	5	8	0	.05	0	28.80	28	5.7	8.5	19	NW	0.5	4	10	10	3
4	76	57	67	-8	57	0	2		0	0	0	28.89	33	8.4	8.8	16	NW	8.1	53	6	6	4
5	67	62	65	-10	60	0	0		0	.06	0	29.01	08	15.1	15.2	25	NE	0.0	0	10	10	5
6	67	60	64	-11	60	1	0	1 8	0	.31	0	28.96	06	10.4	10.8	21	NE	0.0	0	10	10	6
7	71	65	68	-7	63	0	3		0	0	0	28.98	09	9.9	10.1	14	E	0.0	0	10	10	7
8	75	64	70	-4	64	0	5	1	0	T	0	28.99	09	11.6	11.8	17	E	0.2	2	10	10	8
9	81	67	74	0	67	0	9	1	0	T	0	29.05	11	8.0	9.4	15	E	4.6	37	8	7	9
10	86	66	76	2	66	0	11	8	0	T	0	29.05	27	1.2	2.0	8	SE	6.4	51	7	5	10
11	87	67	77	3	67	0	12		0	0	0	29.03	15	1.8	2.7	10	E	12.5	100	3	2	11
12	88	68	78	5	67	0	13	8	0	0	0	29.00	10	1.7	5.0	17	N	12.5	100	3	4	12
13	88*	70	79*	6	67	0	14	8	0	0	0	29.00	04	1.6	5.5	10	E	8.4	67	7	7	13
14	82	69	76	3	67	0	11	1 8	0	T	0	29.00	33	6.1	6.6	14	NW	6.1	49	8	7	14
15	79	63	71	-2	63	0	6	1	0	0	0	29.01	32	7.2	7.8	11	NW	9.2	74	6	5	15
16	82	60	71	-1	65	0	6	2 8	0	0	0	29.00	09	3.2	5.5	10	E	6.3	51	8	5	16
17	86	66	76	4	65	0	11	1 8	0	T	0	28.93	31	5.8	7.3	15	NW	7.5	61	7	4	17
18	83	63	73	1	60	0	8	1 8	0	0	0	28.93	05	4.5	6.0	11	E	10.6	86	3	4	18
19	82	64	73	1	61	0	8	8	0	0	0	29.03	09	7.6	7.9	14	E	11.1	90	4	2	19
20	82	64	73	2	64	0	8	1 8	0	0	0	29.03	11	4.6	5.5	8	E	8.2	67	8	6	20
21	86	65	76	5	65	0	11	3 8	0	.01	0	28.94	28	3.6	7.1	13	N	7.6	62	5	4	21
22	75	60	68	-3	58	0	3		0	0	0	28.97	36	8.4	9.4	15	NE	7.4	61	8	5	22
23	74	51	63	-7	49	2	0		0	0	0	29.06	05	6.4	8.9	15	NE	11.7	96	3	2	23
24	63	52	58	-12	44	7	0		0	T	0	29.14	08	14.7	14.8	26	NE	3.7	31	10	9	24
25	59	51	55*	-15	49	10	0	1 8	0	.12	0	29.00	09	4.5	7.5	14	E	0.0	0	10	10	25
26	67	55	61	-8	58	4	0	1 8	0	.02	0	28.83	12	3.5	5.0	9	N	0.0	0	10	10	26
27	71	63	67	-2	64	0	2	1 8	0	T	0	28.79	10	8.8	9.1	14	E	0.0	0	10	10	27
28	85	67	76	7	65	0	11	2 8	0	T	0	28.86	25	4.9	7.8	12	W	7.3	61	6	7	28
29	79	58	69	1	61	0	4		0	T	0	28.88	29	10.0	12.5	18	W	8.1	68	5	4	29
30	76	49*	63	-6	45	2	0		0	0	0	28.98	33	9.0	9.2	17	NW	11.9	100	0	0	30
	SUM 2344	SUM 1865				TOTAL 26	TOTAL 187			TOTAL 1.06	TOTAL 0	FOR THE MONTH: 28.98	05	2.4	8.0	26	NE	TOTAL 183.9	% FOR MONTH	SUM 209	SUM 191	
	AVG. 78.1	AVG. 62.2	AVG. 70.2	DEP. -2.1	AVG. 61	DEP. 18	DEP. -40			DEP. -2.09						DATE: 24		POSSIBLE 371.4	50	AVG. 7.0	AVG. 6.4	

NUMBER OF DAYS				SEASON TO DATE		NUMBER OF DAYS	
MAXIMUM TEMP.		MINIMUM TEMP.		TOTAL	TOTAL	PRECIPITATION ≥ .01 INCH	8
≥ 90°	≤ 32°	≤ 32°	≤ 0°	28	1454	SNOW, ICE PELLETS ≥ 1.0 INCH	0
0	0	0	0	DEP. 18	DEP. -78	THUNDERSTORMS	3
						HEAVY FOG X	2
						CLEAR 5 PARTLY CLOUDY 10 CLOUDY 15	

GREATEST IN 24 HOURS AND DATES: PRECIPITATION		SNOW, ICE PELLETS	GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE
.37	5-6	0	0

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

Date	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	Date
1														T		.14	.01	T	T	.04					1
2	.03	.05	T	T												.01	.21	T				T	T		2
3									T	T			T	T	.05	T	T								3
4																									4
5												.06	T		T	T	T	T					T	T	5
6		.01	T	T	.01	.02	.02	.23	.02	T	T	T		T	T	T	T	T							6
7																									7
8								T																	8
9			T	T	T																				9
10						T																			10
11																									11
12																									12
13																									13
14												T	T	T											14
15																									15
16																									16
17																			T						17
18																									18
19																									19
20																									20
21											T					T	.01								21
22																									22
23																									23
24																							T	T	24
25			T	T	T		T	.01	.01	.01	.03	.04	.02	T	T	T	T		T	T					25
26			T	T	T	.01	.01		T	T		T												T	26
27	T		T	T			T	T	T	T	T			T	T				T	T	T				27
28	T	T																							28
29									T	T															29
30																									30

* EXTREME TEMPERATURES FOR THE MONTH. MAY BE THE LAST OF MORE THAN ONE OCCURRENCE.
\- BELOW ZERO TEMPERATURE OR NEGATIVE DEPARTURE FROM NORMAL.
‡ ≥ 70° AT ALASKAN STATIONS.
* ALSO ON AN EARLIER DATE, OR DATES.
X HEAVY FOG RESTRICTS VISIBILITY TO 1/4 MILE OR LESS.
T IN THE HOURLY PRECIPITATION TABLE AND IN COLUMNS 9, 10, AND 11 INDICATES AN AMOUNT TOO SMALL TO MEASURE.
THE SEASON FOR DEGREE DAYS BEGINS WITH JULY FOR HEATING AND JANUARY FOR COOLING.
DATA IN COLUMNS 6, 12, 13, 14, AND 15 ARE BASED ON 8 OBSERVATIONS PER DAY AT 3-HOUR INTERVALS.
WIND DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. RESULTANT WIND IS THE VECTOR SUM OF WIND DIRECTIONS AND SPEEDS DIVIDED BY THE NUMBER OF OBSERVATIONS. FIGURES FOR DIRECTIONS ARE TENS OF DEGREES FROM TRUE NORTH: I.E., 09=EAST, 18=SOUTH, 27=WEST, 36=NORTH, AND 00=CALM. WHEN DIRECTIONS ARE IN TENS OF DEGREES IN COL. 17, ENTRIES IN COL. 16 ARE FASTEST OBSERVED 1-MINUTE SPEEDS. IF THE / APPEARS IN COL. 17, SPEEDS ARE GUSTS.
ANY ERRORS DETECTED WILL BE CORRECTED AND CHANGES IN SUMMARY DATA WILL BE ANNOTATED IN THE ANNUAL SUMMARY.

SUBSCRIPTION PRICE: LOCAL CLIMATOLOGICAL DATA $2.00 PER YEAR INCLUDING ANNUAL ISSUE IF PUBLISHED. FOREIGN MAILING 75¢ EXTRA. SINGLE COPY: 20¢ FOR MONTHLY ISSUE; 15¢ FOR ANNUAL SUMMARY. MAKE CHECKS PAYABLE TO DEPARTMENT OF COMMERCE, NOAA. SEND PAYMENTS AND ORDERS TO NATIONAL CLIMATIC CENTER, FEDERAL BUILDING, ASHEVILLE, NORTH CAROLINA 28801.

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA, 28801

William H. Haggard

DIRECTOR, NATIONAL CLIMATIC CENTER

SUMMARY BY HOURS

Hour local time	Averages: Sky cover tenths	Station pressure in.	Temperature: Air °F	Wet bulb °F	Dew pt. °F	Relative humidity %	Wind speed m.p.h.	Resultant wind: Direction	Speed m.p.h.
01	6	28.96	66	63	61	86	7.6	07	2.4
04	6	28.95	64	62	61	87	7.5	04	2.9
07	8	28.97	64	62	60	89	7.2	06	3.2
10	7	29.00	70	65	62	75	9.3	08	2.8
13	7	28.98	75	67	62	65	8.1	03	2.4
16	7	28.94	76	67	62	64	9.0	04	2.0
19	6	28.94	71	65	62	73	8.1	05	2.5
22	5	28.97	68	64	62	81	7.4	04	2.1

ATLANTA, GEORGIA

USCOMM - NOAA ASHEVILLE 625
10/18/74

OBSERVATIONS AT 3-HOUR INTERVALS

NOTES

CEILING COLUMN-
UNL INDICATES NO UNLIMITED CEILING

WEATHER COLUMN-

+	TORNADO
T	THUNDERSTORM
Q	SQUALL
R	RAIN
RW	RAIN SHOWERS
ZR	FREEZING RAIN
L	DRIZZLE
ZL	FREEZING DRIZZLE
S	SNOW
SP	SNOW PELLETS
IC	ICE CRYSTALS
SW	SNOW SHOWERS
SG	SNOW GRAINS
IP	ICE PELLETS
A	HAIL
F	FOG
IF	ICE FOG
GF	GROUND FOG
BD	BLOWING DUST
BN	BLOWING SAND
BS	BLOWING SNOW
BY	BLOWING SPRAY
K	SMOKE
H	HAZE
D	DUST

WIND COLUMNS-

DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. INDICATED IN TENS OF DEGREES FROM TRUE NORTH; I.E., 09 FOR EAST, 18 FOR SOUTH, 27 FOR WEST. ENTRY OF 00 IN THE DIRECTION COLUMN INDICATES CALM.

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STATION: ATLANTA GA YEAR & MONTH: 74 08

U.S. DEPARTMENT OF COMMERCE
NATIONAL CLIMATIC CENTER
FEDERAL BUILDING
ASHEVILLE, N.C. 28801

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POSTAGE AND FEES PAID
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FIRST CLASS

LOCAL CLIMATOLOGICAL DATA

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE

ATLANTA, GEORGIA
NAT WEATHER SERVICE FCST OFC
HARTSFIELD ATLANTA INTL AP
OCTOBER 1974

LATITUDE 33° 39′ N   LONGITUDE 84° 26′ W   ELEVATION (GROUND) 1010 FT.   STANDARD TIME USED: EASTERN   WBAN #13874

DATE	TEMPERATURE °F: MAXIMUM	MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	AVERAGE DEW POINT	DEGREE DAYS BASE 65°: HEATING	COOLING	WEATHER TYPES ON DATES OF OCCURRENCE (1 FOG, 2 HEAVY FOG X, 3 THUNDERSTORM, 4 ICE PELLETS, 5 HAIL, 6 GLAZE, 7 DUSTSTORM, 8 SMOKE, HAZE, 9 BLOWING SNOW)	SNOW, ICE PELLETS OR ICE ON GROUND AT 07AM IN.	PRECIPITATION: WATER EQUIVALENT IN.	SNOW, ICE PELLETS IN.	AVG. STATION PRESSURE IN. ELEV. 1034 FEET M.S.L.	WIND: RESULTANT DIRECTION	RESULTANT SPEED M.P.H.	AVERAGE SPEED M.P.H.	FASTEST MILE: SPEED M.P.H.	DIRECTION	SUNSHINE: HOURS AND TENTHS	PERCENT OF POSSIBLE	SKY COVER TENTHS: SUNRISE TO SUNSET	MIDNIGHT TO MIDNIGHT	DATE
1	2	3	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	75	46	61	-7	30	4	0		0	0	0	29.01	34	7.0	7.2	13	NW	11.8	100	0	0	1
2	65	45	55	-12	33	10	0		0	0	0	29.14	35	11.0	11.5	18	NW	11.7	99	2	1	2
3	64	41	53	-14	29	12	0		0	0	0	29.30	01	5.5	7.1	13	E	11.8	100	0	0	3
4	66	39	53	-14	32	12	0		0	0	0	29.32	08	6.2	6.6	12	E	11.7	100	2	1	4
5	73	40	57	-8	34	8	0		0	0	0	29.30	07	6.7	7.2	11	E	11.7	100	0	0	5
6	78	48	63	-3	37	2	0		0	0	0	29.18	06	7.3	7.8	14	E	11.7	100	0	0	6
7	81	52	67	1	47	0	2		0	0	0	29.00	35	8.4	8.9	16	NW	11.6	100	0	0	7
8	74	50	62	-3	50	3	0		0	0	0	28.94	35	4.2	5.5	12	NW	9.1	79	8	5	8
9	75	45	60	-5	45	5	0	8	0	0	0	28.94	36	4.0	4.3	9	W	11.6	100	0	0	9
10	78	47	63	-2	44	2	0		0	0	0	29.03	33	2.0	4.0	9	W	11.6	100	0	0	10
11	81	51	66	2	50	0	1		0	0	0	29.15	20	.9	3.7	7	NW	10.3	90	2	1	11
12	81	53	67	3	51	0	2	8	0	0	0	29.21	24	2.8	4.2	8	W	7.6	66	4	3	12
13	80	61	71	7	53	0	6	8	0	0	0	29.13	26	3.3	4.5	9	W	4.6	40	7	7	13
14	80	55	68	5	55	0	3	8	0	0	0	29.06	20	4.1	4.6	13	S	4.9	43	9	8	14
15	82*	63	73*	10	61	0	8	1 8	0	.45	0	28.94	18	5.9	6.5	18	W	3.3	29	9	8	15
16	65	50	58	-4	55	7	0	1	0	.77	0	28.85	30	8.7	9.9	17	NW	0.0	0	10	8	16
17	72	46	59	-3	45	6	0	1 8	0	0	0	28.94	33	8.1	8.3	16	NW	11.3	100	0	0	17
18	77	49	63	1	43	2	0		0	0	0	28.91	33	7.8	8.1	15	NW	11.3	100	0	0	18
19	65	45	55	-8	34	10	0		0	0	0	28.98	35	10.3	10.6	23	N	11.3	100	1	1	19
20	67	37	52	-9	32	13	0		0	0	0	29.13	33	5.9	7.1	16	W	11.2	100	0	0	20
21	60	38	49*	-12	29	16	0		0	0	0	29.40	08	8.7	9.6	23	E	11.2	100	0	0	21
22	64	35*	50	-10	26	15	0		0	0	0	29.49	11	4.9	5.9	14	E	11.1	100	3	2	22
23	70	36	53	-7	30	12	0		0	0	0	29.30	32	5.5	6.0	15	W	11.1	100	0	0	23
24	74	44	59	0	35	6	0		0	0	0	29.15	06	1.2	4.9	10	E	6.2	56	7	4	24
25	77	47	62	3	43	3	0	8	0	0	0	29.17	27	2.4	3.3	12	NW	9.4	85	6	3	25
26	81	52	67	8	49	0	2		0	0	0	29.13	31	6.6	6.9	11	NW	11.0	100	0	0	26
27	81	55	68	10	52	0	3	8	0	0	0	29.05	31	4.1	4.5	9	SW	8.8	80	2	1	27
28	79	52	66	8	49	0	1	8	0	0	0	29.03	18	2.3	4.6	11	S	9.7	88	5	4	28
29	79	55	67	9	53	0	2	1 8	0	T	0	29.13	13	4.6	5.0	15	SE	7.0	64	8	8	29
30	79	62	71	14	58	0	6		0	0	0	29.23	14	3.8	4.0	10	E	6.2	57	5	5	30
31	81	59	70	13	54	0	5	1 8	0	0	0	29.16	13	3.9	4.2	13	E	10.9	100	1	0	31

SUM	SUM				TOTAL	TOTAL	NUMBER OF DAYS		TOTAL	TOTAL	FOR THE MONTH:						TOTAL	%	SUM	SUM
2304	1498				148	41	PRECIPITATION		1.22	0	29.12	35	2.2	6.3	23	E	292.7	FOR MONTH	91	72
AVG.	AVG.	AVG.	DEP.	AVG.	DEP.	DEP.	≥ .01 INCH	2	DEP.						DATE: 21+		POSSIBLE		AVG.	AVG.
74.3	48.3	61.3	-1.1	43	11	-16			-1.28								351.6	83	2.9	2.3

NUMBER OF DAYS: MAXIMUM TEMP. ≥ 90	MAXIMUM TEMP. ≤ 32	MINIMUM TEMP. ≤ 32	MINIMUM TEMP. ≤ 0	SEASON TO DATE: HEATING TOTAL	COOLING TOTAL
0	0	0	0	174	1405
				DEP. 29	DEP. -94

SNOW, ICE PELLETS ≥ 1.0 INCH 0
THUNDERSTORMS 0
HEAVY FOG X 0
CLEAR 20   PARTLY CLOUDY 6   CLOUDY 5

GREATEST IN 24 HOURS AND DATES: PRECIPITATION 1.22 15-16; SNOW, ICE PELLETS 0

GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE: 0

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT: 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT: 1	2	3	4	5	6	7	8	9	10	11	12	DATE
1																									1
2																									2
3																									3
4																									4
5																									5
6																									6
7																									7
8																									8
9																									9
10																									10
11																									11
12																									12
13																									13
14																									14
15																		T	T	T	.19	.21	.05		15
16	.06	.13	.16	.24	.13	.05	T																		16
17																									17
18																									18
19																									19
20																									20
21																									21
22																									22
23																									23
24																									24
25																									25
26																									26
27																									27
28																									28
29																	T	T		T					29
30																									30
31																									31

* EXTREME TEMPERATURES FOR THE MONTH. MAY BE THE LAST OF MORE THAN ONE OCCURRENCE.
\- BELOW ZERO TEMPERATURE OR NEGATIVE DEPARTURE FROM NORMAL.
≥ 70° AT ALASKAN STATIONS.
* ALSO ON AN EARLIER DATE, OR DATES.
X HEAVY FOG RESTRICTS VISIBILITY TO 1/4 MILE OR LESS.
T IN THE HOURLY PRECIPITATION TABLE AND IN COLUMNS 9, 10, AND 11 INDICATES AN AMOUNT TOO SMALL TO MEASURE.

THE SEASON FOR DEGREE DAYS BEGINS WITH JULY FOR HEATING AND JANUARY FOR COOLING.
DATA IN COLUMNS 6, 12, 13, 14, AND 15 ARE BASED ON 8 OBSERVATIONS PER DAY AT 3-HOUR INTERVALS.
WIND DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. RESULTANT WIND IS THE VECTOR SUM OF WIND DIRECTIONS AND SPEEDS DIVIDED BY THE NUMBER OF OBSERVATIONS. FIGURES FOR DIRECTIONS ARE TENS OF DEGREES FROM TRUE NORTH; I.E., 09=EAST, 18=SOUTH, 27=WEST, 36=NORTH, AND 00=CALM. WHEN DIRECTIONS ARE IN TENS OF DEGREES IN COL. 17, ENTRIES IN COL. 16 ARE FASTEST OBSERVED 1-MINUTE SPEEDS. IF THE / APPEARS IN COL. 17, SPEEDS ARE GUSTS.
ANY ERRORS DETECTED WILL BE CORRECTED AND CHANGES IN SUMMARY DATA WILL BE ANNOTATED IN THE ANNUAL SUMMARY.

SUBSCRIPTION PRICE: LOCAL CLIMATOLOGICAL DATA $2.00 PER YEAR INCLUDING ANNUAL ISSUE IF PUBLISHED. FOREIGN MAILING 75¢ EXTRA. SINGLE COPY: 20¢ FOR MONTHLY ISSUE; 15¢ FOR ANNUAL SUMMARY. MAKE CHECKS PAYABLE TO DEPARTMENT OF COMMERCE, NOAA. SEND PAYMENTS AND ORDERS TO NATIONAL CLIMATIC CENTER, FEDERAL BUILDING, ASHEVILLE, NORTH CAROLINA 28801.

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA, 28801

William H. Haggard

DIRECTOR, NATIONAL CLIMATIC CENTER

SUMMARY BY HOURS

HOUR LOCAL TIME	AVERAGES: SKY COVER TENTHS	STATION PRESSURE IN.	TEMPERATURE: AIR °F	WET BULB °F	DEW PT. °F	RELATIVE HUMIDITY %	WIND SPEED M.P.H.	RESULTANT WIND: DIRECTION	SPEED M.P.H.
01	1	29.11	54	48	43	68	5.6	33	2.8
04	2	29.11	52	48	44	74	5.6	36	2.8
07	3	29.14	50	47	43	77	5.2	01	2.8
10	3	29.17	63	54	46	53	7.8	08	1.9
13	3	29.13	71	56	43	37	8.3	35	2.3
16	3	29.08	73	57	43	35	7.9	34	2.8
19	2	29.10	65	54	43	47	5.6	35	2.3
22	1	29.12	58	51	44	59	5.0	34	1.3

USCOMM - NOAA - ASHEVILLE   829
11/18/74

ATLANTA, GEORGIA

OBSERVATIONS AT 3-HOUR INTERVALS

HOUR	SKY COVER	CEILING	VISIBILITY WHOLE MILES	16THS MILE	WEATHER	DRY BULB	WET BULB	DEW PT	REL HUM %	WIND DIR	SPEED KNOTS
DAY 01											
01	0	UNL	12			54	48	43	67	32	7
04	0	UNL	12			50	44	38	64	33	8
07	0	UNL	12			48	45	38	77	33	7
10	0	UNL	12			62	50	37	40	36	8
13	0	UNL	12			71	53	36	27	36	6
16	0	UNL	12			74	55	38	27	34	7
19	0	UNL	12			66	51	38	37	32	3
22	0	UNL	12			60	50	40	48	32	4
DAY 02											
01	0	UNL	12			56	48	38	53	33	11
04	0	UNL	12			51	45	38	64	33	7
07	4	UNL	12			48	44	38	68	33	8
10	2	UNL	12			60	48	37	43	36	13
13	6	UNL	12			63	48	26	25	01	15
16	0	UNL	12			64	48	31	28	34	8
19	0	UNL	12			55	43	26	33	33	8
22	0	UNL	12			47	38	27	46	36	8
DAY 03											
01	0	UNL	12			44	38	28	56	36	8
04	0	UNL	12			43	38	30	60	03	6
07	0	UNL	12			41	36	28	62	06	7
10	0	UNL	12			48	40	28	46	06	7
13	0	UNL	12			58	46	28	32	33	5
16	0	UNL	12			64	48	28	27	36	7
19	0	UNL	12			56	43	27	33	34	5
22	0	UNL	12			51	40	26	38	32	4
DAY 04											
01	0	UNL	12			40	38	30	58	08	5
04	0	UNL	12			42	38	32	68	07	7
07	0	UNL	12			38	36	31	73	08	7
10	1	UNL	12			54	43	29	38	13	7
13	2	UNL	12			61	47	31	32	08	5
16	3	UNL	12			66	50	33	30	08	5
19	2	UNL	12			57	46	34	42	10	5
22	0	UNL	12			50	45	38	57	12	5
DAY 05											
01	0	UNL	12			48	40	34	68	10	8
04	0	UNL	12			42	38	33	71	07	5
07	0	UNL	12			44	38	33	65	04	5
10	0	UNL	12			57	46	33	40	06	8
13	0	UNL	12			67	48	30	25	04	7
16	0	UNL	12			72	52	31	22	07	8
19	0	UNL	12			62	48	36	38	10	6
22	0	UNL	12			56	47	38	51	06	5
DAY 06											
01	0	UNL	12			50	43	35	57	07	3
04	0	UNL	12			48	43	35	58	07	6
07	0	UNL	12			50	43	35	57	03	7
10	0	UNL	12			66	50	33	30	08	12
13	0	UNL	12			75	55	35	23	08	8
16	0	UNL	12			77	57	40	27	07	6
19	0	UNL	12			72	56	41	33	04	6
22	0	UNL	12			65	53	42	43	05	6
DAY 07											
01	0	UNL	12			60	51	43	54	02	6
04	0	UNL	12			57	50	44	62	03	7
07	0	UNL	12			55	48	44	67	33	7
10	0	UNL	12			68	56	46	46	36	7
13	0	UNL	12			78	60	48	32	36	12
16	0	UNL	12			78	60	48	31	36	11
19	0	UNL	12			71	60	52	51	33	6
22	0	UNL	12			66	58	53	65	33	6
DAY 08											
01	0	UNL	10			56	53	51	83	31	7
04	0	UNL	10			52	50	48	86	33	4
07	8	250	7			50	48	47	88	35	7
10	10	100	8			62	55	48	63	06	10
13	8	100	10			70	58	51	51	36	3
16	8	160	10			72	60	51	48	31	3
19	3	UNL	10			65	57	51	61	36	4
22	0	UNL	8			58	54	50	75	00	0
DAY 09											
01	0	UNL	7			55	53	51	86	00	0
04	0	UNL	7			53	50	48	83	34	5
07	0	UNL	5		H	48	48	47	83	04	5
10	0	UNL	4		KH	64	57	52	65	03	2
13	0	UNL	6		H	72	56	42	34	36	5
16	0	UNL	8			75	56	40	28	02	5
19	0	UNL	12			65	53	41	42	34	3
22	0	UNL	12			63	51	40	43	36	5
DAY 10											
01	0	UNL	12			58	48	42	62	34	4
04	0	UNL	8			51	47	43	74	00	0
07	2	UNL	7			50	46	43	77	36	4
10	0	UNL	7			66	56	48	56	14	6
13	0	UNL	7			76	57	42	30	26	5
16	0	UNL	12			77	58	48	32	34	6
19	0	UNL	12			72	57	44	37	36	4
22	0	UNL	12			63	53	48	62	00	0
DAY 11											
01	0	UNL	12			55	50	46	72	09	4
04	0	UNL	10			52	48	47	83	00	0
07	4	UNL	7			53	50	48	83	35	3
10	0	UNL	7			71	60	53	53	26	4
13	2	UNL	8			78	62	51	38	28	3
16	4	UNL	8			80	63	51	36	22	5
19	2	UNL	8			70	60	52	53	13	4
22	0	UNL	8			64	58	53	68	15	3
DAY 12											
01	0	UNL	7			61	56	52	72	22	6
04	0	UNL	7			56	52	50	83	27	4
07	2	UNL	5		RH	54	52	50	86	11	3
10	7	80	6		RH	68	58	53	58	24	4
13	3	UNL	7			78	62	51	38	25	4
16	6	UNL	8			78	62	50	36	32	4
19	6	UNL	8			71	58	51	48	00	0
22	2	UNL	7			63	58	54	73	21	4
DAY 13											
01	8	80	7			63	56	51	65	23	5
04	8	70	7			64	58	53	68	30	5
07	10	65	5		RH	62	58	56	78	24	3
10	10	80	6		RH	68	61	56	61	32	4
13	7	UNL	7			78	63	52	40	24	4
16	4	UNL	7			78	61	48	36	32	4
19	6	UNL	6		RH	68	60	54	61	20	3
22	5	UNL	6		R	64	58	54	70	24	3
DAY 14											
01	8	250	10			61	56	53	75	00	0
04	10	240	10			58	56	53	81	00	0
07	8	240	5		RH	57	55	53	87	00	0
10	10	240	12			71	64	58	66	21	10
13	8	UNL	12			78	64	55	49	21	8
16	10	240	12			77	63	53	43	21	8
19	6	UNL	12			70	61	55	58	15	3
22	8	110	10			66	61	58	75	13	3
DAY 15											
01	4	UNL	12			66	62	58	78	14	5
04	5	UNL	12			65	63	62	90	17	6
07	10	2	1	8	F	63	62	62	87	18	5
10	7	250	6		RH	73	67	63	71	16	5
13	10	100	12			80	67	60	51	20	8
16	10	120	12			78	66	58	50	20	6
19	10	80	10		R	72	65	60	66	18	3
22	10	32	4		RF	67	66	64	90	22	7
DAY 16											
01	10	11	12			63	61	60	90	31	8
04	10	4	4		GF	62	62	62	100	31	4
07	10	3	8			60	58	58	93	28	7
10	10	6	12			61	58	57	87	28	8
13	10	10	12			60	57	54	81	31	11
16	10	11	10			58	56	52	78	31	13
19	10	14	10			57	53	48	75	30	10
22	2	UNL	10			54	50	47	77	30	8
DAY 17											
01	0	UNL	10			48	47	46	88	32	5
04	0	UNL	10			48	46	44	83	34	12
07	0	UNL	5		GFK	46	44	43	89	34	5
10	0	UNL	5		K	57	51	46	67	36	6
13	1	UNL	8			68	58	50	53	34	5
16	0	UNL	10			72	58	47	41	34	7
19	0	UNL	12			58	50	41	51	34	10
22	0	UNL	12			55	48	41	58	30	8
DAY 18											
01	0	UNL	12			51	47	43	74	30	5
04	0	UNL	12			52	47	42	68	34	4
07	0	UNL	7			51	47	42	71	33	4
10	0	UNL	8			67	55	46	46	34	7
13	0	UNL	10			75	58	46	36	32	12
16	0	UNL	12			76	58	43	31	34	8
19	0	UNL	12			67	53	40	37	32	8
22	1	UNL	12			64	52	40	42	34	7
DAY 19											
01	0	UNL	12			56	48	41	57	32	11
04	0	UNL	12			51	46	38	64	36	7
07	0	UNL	12			48	44	38	71	33	3
10	3	UNL	12			57	48	40	53	36	14
13	0	UNL	12			62	46	25	24	36	14
16	0	UNL	12			64	48	30	28	36	12
19	0	UNL	12			56	43	28	37	34	8
22	0	UNL	12			46	40	32	58	32	5
DAY 20											
01	0	UNL	12			42	38	33	71	32	4
04	0	UNL	12			42	38	32	68	36	5
07	0	UNL	12			38	35	31	76	34	5
10	0	UNL	12			55	44	30	38	14	3
13	0	UNL	12			64	48	31	28	31	10
16	0	UNL	12			66	50	33	29	34	12
19	0	UNL	12			58	47	34	41	32	6
22	0	UNL	12			52	44	35	53	36	4
DAY 21											
01	0	UNL	12			48	40	33	61	35	5
04	0	UNL	12			43	38	32	65	07	10
07	0	UNL	12			38	33	26	62	08	10
10	0	UNL	12			48	38	26	38	10	12
13	0	UNL	12			56	44	28	34	10	10
16	0	UNL	12			58	46	30	33	08	6
19	0	UNL	12			51	42	30	46	08	7
22	0	UNL	12			44	37	27	51	08	7
DAY 22											
01	0	UNL	12			40	34	25	55	08	4
04	4	UNL	12			38	33	25	60	08	5
07	8	UNL	12			38	33	25	60	06	6
10	8	UNL	12			52	41	25	35	12	11
13	0	UNL	12			61	46	25	25	16	6
16	8	UNL	12			63	47	28	27	15	5
19	0	UNL	10			57	45	30	36	11	2
22	0	UNL	10			53	41	26	35	07	3
DAY 23											
01	0	UNL	12			47	38	26	44	34	3
04	0	UNL	12			40	37	32	73	34	4
07	0	UNL	10			38	35	28	67	00	0
10	0	UNL	12			57	46	32	38	27	6
13	0	UNL	12			68	48	28	22	33	10
16	0	UNL	12			70	50	28	22	33	7
19	0	UNL	12			56	46	31	38	32	6
22	0	UNL	12			51	42	32	48	33	5
DAY 24											
01	0	UNL	12			47	40	32	56	32	4
04	0	UNL	12			47	40	32	56	36	5
07	1	UNL	8			48	41	32	54	05	4
10	7	230	10			65	50	34	32	12	7
13	8	230	8			71	53	36	28	07	5
16	8	140	12			72	53	36	26	17	5
19	5	UNL	12			62	50	38	41	27	4
22	0	UNL	10			56	48	42	62	00	0
DAY 25											
01	0	UNL	10			52	48	46	80	26	3
04	0	UNL	10			50	46	43	77	36	3
07	10	UNL	6		R	51	47	42	71	00	0
10	2	UNL	6		RH	67	58	48	48	00	0
13	7	UNL	7			75	57	41	30	24	5
16	6	UNL	8			76	57	41	28	26	4
19	3	UNL	8			70	55	43	38	33	3
22	0	UNL	8			62	53	44	52	23	5
DAY 26											
01	2	UNL	10			54	48	44	68	30	7
04	0	UNL	10			53	48	46	74	30	6
07	0	UNL	10			52	48	45	77	31	6
10	0	UNL	10			66	57	48	51	34	8
13	0	UNL	10			76	62	51	38	34	9
16	0	UNL	12			80	63	52	38	31	7
19	0	UNL	10			68	58	52	56	32	4
22	0	UNL	10			61	56	52	72	28	4
DAY 27											
01	0	UNL	10			60	55	52	75	30	4
04	0	UNL	10			58	55	52	81	28	4
07	5	UNL	5		H	57	54	52	83	34	4
10	0	UNL	7			68	58	53	58	30	4
13	1	UNL	10			78	63	52	40	28	6
16	2	UNL	10			76	60	48	38	28	4
19	0	UNL	7			73	60	50	44	36	5
22	0	UNL	7			64	57	52	65	00	0
DAY 28											
01	0	UNL	7			58	54	51	78	28	6
04	2	UNL	8			55	53	51	86	25	4
07	1	UNL	4		RH	56	52	50	83	00	0
10	2	UNL	5		RH	66	60	54	58	11	4
13	8	UNL	8			77	62	51	40	17	6
16	7	UNL	12			78	58	44	30	18	5
19	4	UNL	12			68	56	44	42	13	4
22	7	UNL	12			62	54	47	58	14	4
DAY 29											
01	5	UNL	10			60	53	47	62	09	4
04	5	UNL	10			58	55	52	78	14	4
07	2	UNL	6		RH	55	53	52	90	09	3
10	10	UNL	6		R	68	63	58	71	15	6
13	8	UNL	12			78	63	53	42	14	8
16	10	140	12			76	62	53	45	16	4
19	10	120	12			72	61	54	53	13	3
22	10	140	12			66	60	54	58	12	3
DAY 30											
01	8	100	10			66	60	55	68	00	0
04	8	100	10			65	61	58	81	14	6
07	8	100	10			62	60	58	87	00	0
10	10	100	7			68	62	58	73	16	5
13	2	UNL	8			78	67	60	54	16	6
16	2	UNL	12			78	65	57	47	13	5
19	0	UNL	12			70	62	57	64	11	3
22	0	UNL	10			66	60	56	70	11	4
DAY 31											
01	8	UNL	10			64	58	55	73	00	0
04	0	UNL	10			60	57	54	81	00	0
07	0	UNL	5		GFK	58	56	54	84	08	4
10	0	UNL	4		K	66	63	60	73	13	5
13	1	UNL	8			78	64	54	42	12	8
16	8	UNL	12			80	64	53	38	14	5
19	0	UNL	12			70	60	53	55	14	4
22	8	UNL	10			66	58	52	61	16	3

ADDITIONAL DATA

OTHER OBSERVATIONAL DATA CONTAINED IN RECORDS ON FILE CAN BE FURNISHED AT COST VIA MICROFILM, MICROFICHE, OR PAPER COPIES OF THE ORIGINAL RECORDS. INQUIRIES AS TO AVAILABILITY AND COSTS SHOULD BE ADDRESSED TO: DIRECTOR, NATIONAL CLIMATIC CENTER, FEDERAL BUILDING, ASHEVILLE, NORTH CAROLINA 28801.

STATION: ATLANTA GA   YEAR & MONTH: 74 10

NOTES

CEILING COLUMN-
UNL INDICATES AN UNLIMITED CEILING

WEATHER COLUMN-

- T TORNADO
- T THUNDERSTORM
- Q SQUALL
- R RAIN
- RW RAIN SHOWERS
- ZR FREEZING RAIN
- L DRIZZLE
- ZL FREEZING DRIZZLE
- S SNOW
- SP SNOW PELLETS
- IC ICE CRYSTALS
- SW SNOW SHOWERS
- SG SNOW GRAINS
- IP ICE PELLETS
- A HAIL
- F FOG
- IF ICE FOG
- GF GROUND FOG
- BD BLOWING DUST
- BN BLOWING SAND
- BS BLOWING SNOW
- BY BLOWING SPRAY
- K SMOKE
- H HAZE
- D DUST

WIND COLUMNS-

DIRECTIONS ARE THOSE FROM WHICH THE WIND BLOWS. INDICATED IN TENS OF DEGREES FROM TRUE NORTH; I.E., 09 FOR EAST, 18 FOR SOUTH, 27 FOR WEST. ENTRY OF 00 IN THE DIRECTION COLUMN INDICATES CALM.

SPEED IS EXPRESSED IN KNOTS; MULTIPLY BY 1.15 TO CONVERT TO MILES PER HOUR.

U.S. DEPARTMENT OF COMMERCE
NATIONAL CLIMATIC CENTER
FEDERAL BUILDING
ASHEVILLE, N.C. 28801

APPENDIX C

CHATTAHOOCHEE RIVER FIELD INSPECTIONS

APPENDIX C

CHATTAHOOCHEE RIVER FIELD INSPECTIONS*

By

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BACKGROUND AND PURPOSE

The U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) is adapting a dynamic water quality ecologic model to the Chattahoochee River in Georgia. While the model can calculate the population dynamics of algae, zooplankton, benthic animals and fish, time and budget do not allow for a detailed calibration of that portion of the model. Since the primary purpose of the model will be to evaluate the transient water quality impact of urban runoff and waste discharges, the biological section of the model was modified, on an interim basis, to remain constant during the simulation.

To provide a good estimate of the biological "constant" and to become familiar with the general setting of the river, a field inspection with a helicopter was made on August 18, 1975. The crew included Mr. R. G. Willey of HEC, Mr. Larry Lyons of the Savannah District Corps of Engineers, Mr. Larry Neal of the Georgia Department of Natural Resources, Environmental Protection Division, and myself. After the field trip, I had discussions with biologist, Mr. Daniel R. Holder of the Georgia Department of Natural Resources, Game and Fish Division, and Mr. R. M. Gaddis of the Georgia Department of Natural Resources, Environ-

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*Report submitted to Hydrologic Engineering Center for a consulting assignment, Contract DACW05-5-76-P-0481

mental Protection Division. Pertinent reports on water quality and biological surveys were reviewed.

This brief report documents the findings of the field inspection and the discussion with local field biologists.

RIVER SETTING

The headwater of the Chattahoochee River originates from Buford Dam behind Lake Lanier, a very clean body of water. Water is released for hydro-power generation during the peak hours of power demand on weekdays. The minimum flow of the river is 600 cfs. During the course of a day, the flow of the river can change drastically.

The river is full of shoal areas with riffles and pools. Exceptions are the areas subject to the backwater effects of low level dams, i.e., Morgan Falls Dam and West Point. Shallow areas are approximately two to three feet deep and pool areas six feet deep. The velocity of the river flow is approximately one to three feet per second.

The river banks are full of trees that may drop leaves into the river. Urban developments and spot deforestations along the river appear to contribute heavy sediment loads to the river. The turbidity increases as the river receives tributary flows downstream.

FISHERY RESOURCES

Before the construction of Buford Dam, the river was primarily full of warm water fish. The low level release of water

from Buford Dam makes the upstream section of the river suitable for cold water fish.

Within the study area, the river can be divided into three sections in terms of fishery resources. The cold water section extends from Buford Dam to the Atlanta Water Works Intake. From Atlanta to Franklin is a section that has been polluted by sewage, industrial wastes and thermal discharges. From Franklin to West Point is a section that has recovered from upstream pollution.

The water quality in Section I has been suitable for water supply and cold water fishery. Georgia Fish and Game has stocked this area with both fingerlings and trout of catchable size. Eighty thousand (80,000) fish per year of catchable size are planted from April to October. It is estimated that the standing crop of cold water fish is on the order of thirty (30) to fifty (50) lb/acre. This is equivalent to approximately thirty-five (35) to sixty (60) lb/river mile. For model simulation, five (5) lb/mile may be used for cold water fish on a dry weight basis. For warm water fish and bottom feeders, one half (0.5) lb/mile may be appropriate.

For Section II, it was felt that the river was too polluted to support any fishery. However, the low values of 0.1 lb/mile for cold water fish and 2 lb/mile for warm water fish and bottom feeders may be assigned.

For Section III, warm water fishery predominates. Fishery biologists feel that the standing crop of warm water fish should be on the order of 200 to 300 lb/acre. In a pre-impoundment survey of the proposed West Point Reservoir, W. L. Shelton of Auburn University reported a value of 100 lb/acre, predominantly sunfish (L. Auritus), large mouth bass (N. Salmonoides), and

channel catfish (Panctatus). For model simulation, approximately 12 to 15 lb/mile of warm water fish on a dry weight basis is appropriate. Among them, 4 to 5 lb/mile are bottom feeders. Cold water fish may be 0.5 lb/mile.

ORGANIC SEDIMENT

Total organic carbon in the water ranges from 1 to 7 mg/l as C. The detritus content of the water is therefore 2 to 14 mg/l.

The solid content of organic sediment ranges from 60 to 80 percent. The volatile solid fraction ranges from 2 to 6 percent. Chemical oxygen demand ranges from 20,000 to 68,000 mg/kg. Assuming a specific gravity of 1.6 to 2.0 for sediment, the organic content in the top two (2) inches of depth is calculated to range from 5 g/m^2 to 15 g/m^2. The low value is a reflection of flow characteristics as well as waste discharge conditions.

Based on this calculation, it is proposed that 10 g/m^2 be used for river reaches that do not receive waste water discharges. Downstream of waste discharges, 20 g/m^2 of organic sediment may be assigned. For the river reaches subject to backwater effects of a low level dam, organic sediment may be 150-200 g/m^2.

ALGAL DENSITY

Water released from Buford Dam contains little algae because of the low level intake structure. River water is soft, containing little nutrients, i.e., 0.02 - 0.15 mg/l NH_3N, 0.02 - 0.05 mg/l PO_4P, 0.2-0.7 mg/l NO_3N. Flow is swift, providing little residence time for algal growth.

For these reasons, chlorophyll a content is low, i.e., 0.5 to 2 μg/l. This is equivalent to 0.001 mg/l of algae on a dry weight basis. This will have zero impact on the oxygen resources of the river. Oxygenation of the river water comes primarily from surface reaeration.

Zooplankton density has not been reported. It may be presumed low, near zero.

Benthic (periphyton) algae has been monitored by the U.S. Geological Survey. For the upstream section, the periphyton density is on the order of 1.1 g/m^2. In the polluted section, non-chlorophyllous unit predominate (~ 3 g/m^2). Downstream, chlorophyllous periphyton grows to approximately 4 g/m^2.

MACROINVERTEBRATES

The benthic animal population was studied by submerging limestone substrate (LSS) in the river water for two months. Animals that colonized on the substrate were obtained for qualitative and quantitative analysis. Surface areas of LSS were not reported. For this calculation, it is assumed to be one square foot. The estimated value can be adjusted accordingly when the surface area of LSS becomes available at a later date.

The benthic animal densities were reported to be 0.538 g/LSS at Cobb County water intake, 0.366 g/LSS at Georgia Highway 92 bridge, and 0.127 g/LSS at U.S. Highway 27 bridge. It is not known if the biomass was expressed in dry or wet weight. Judging from the relative order of magnitude, they are presumed to be wet weight. Assuming the surface area of LSS to be one square foot, these values are converted to 5.8 g/m^2, 3.9 g/m^2, and 1.4 g/m^2 respectively.

The biomass by the LSS method represents only that fraction of animals favoring stone strata. There is no known ratio between LSS biomass to total biomass.

Estimates can only be made on a rough basis. For the model, it is proposed to use the following data.

1. From Buford Dam to Gwinnett Intake 0.3 g/m^2

2. From Gwinnett Intake to Dekalb Intake 0.6 g/m^2

3. From Dekalb Intake to Morgan Falls Dam 1.0 g/m^2

4. From Atlanta to Franklin 0.2 g/m^2, and

5. From Franklin to Westport 0.6 g/m^2

All the values are on a dry weight basis. It must be noted that benthic animal biomass in the upper clean water reaches will be mostly insects. From Atlanta to Franklin, they will be mostly oligochaet worms. From Franklin to West Point, a mixture of both will exist on the substrate.

APPENDIX D

EXAMPLE INPUT DATA

Table of Contents

INFLOW QUALITY

Parameter		Source	Remarks (Buford Dam Release, River Mile 456.2)	Quality
TEMP	°F	Mobile Dist.	daily grab 1/ sample	52
OXY	mg/l	Mobile Dist.	time variant	2/
BOD5	mg/l	AWW	mean of grab samples	0.8
COLIF	col./100 ml	AWW	mean of grab samples	10
DETRITUS	mg/l	estimate		.60
NH3	mg/l (N)	AWW	mean of grab samples	0.13
NO3	mg/l (N)	AWW	mean of grab samples	0.39
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	AWW	mean of grab samples	0.05
TDS	mg/l	AWW	mean of grab samples	33
ALGAE(1)	mg/l	estimate		.08
ALGAE(2)	mg/l	estimate		.04
ZOO	mg/l	estimate		.006
PH		Mobile Dist.	daily grab 3/ sample	6.6
ALKA	mg/l ($CaCO_3$)	AWW	mean of grab sample	10.5

1/ see figure D - 1

2/ see figure D - 3

3/ see figure D - 2

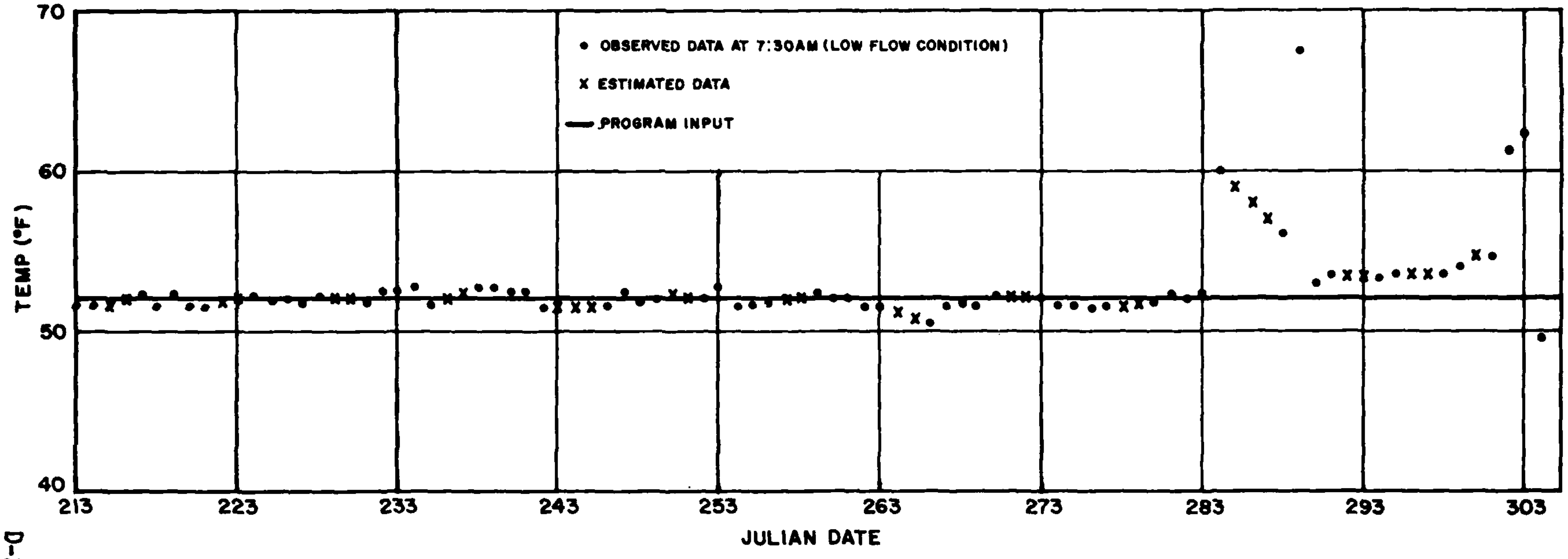

Figure D-1. BUFORD TEMPERATURE vs TIME

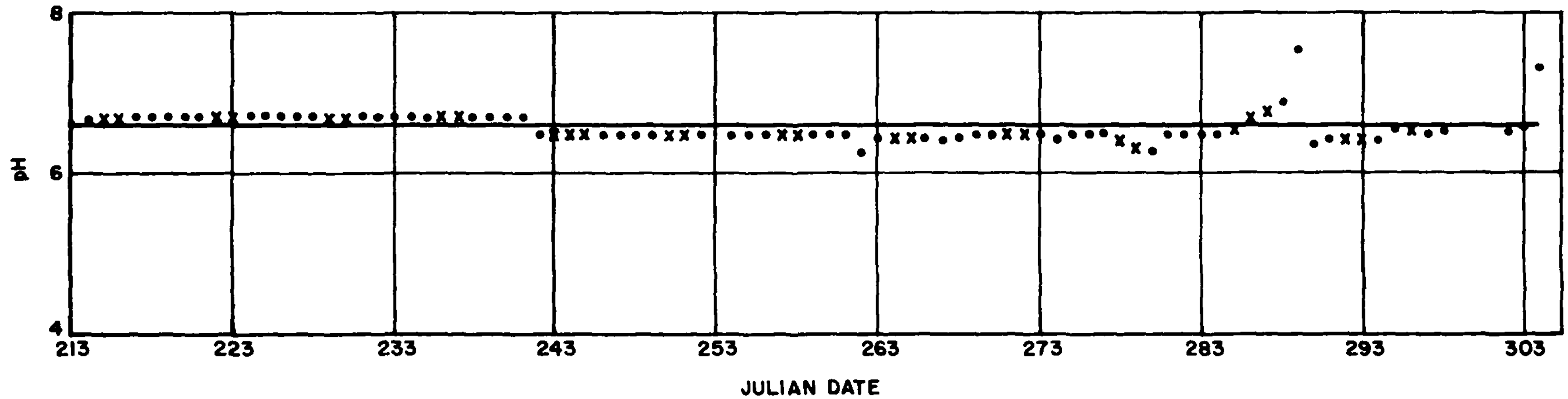

Figure D-2. BUFORD pH vs TIME

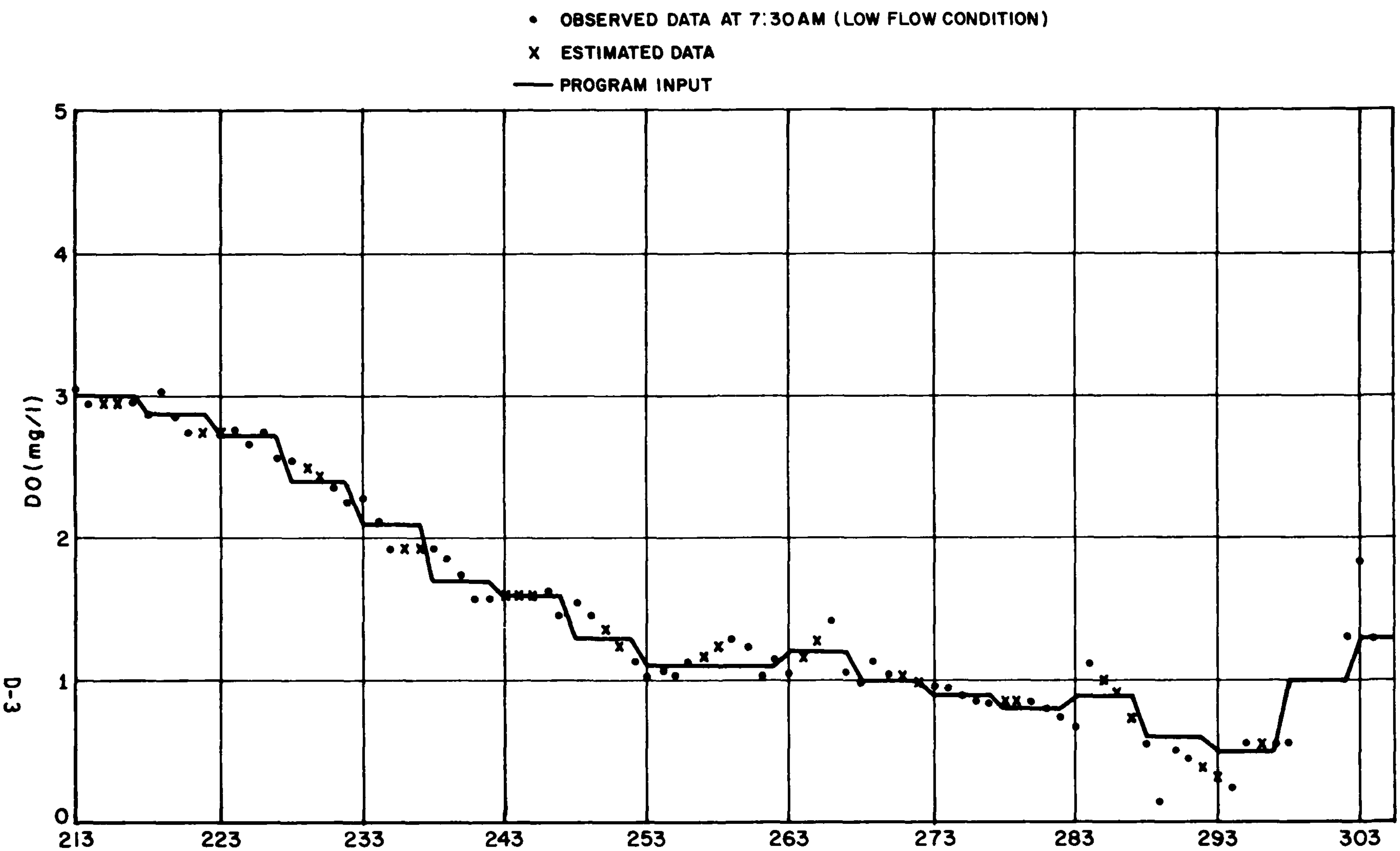

Figure D-3 BUFORD DO vs TIME

INFLOW QUALITY

Parameter		Source	Buford Local River Mile 451.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		8
BOD5	mg/l	estimate		1
COLIF	col./100 ml	estimate		100
DETRITUS	mg/l	estimate		0.5
NH3	mg/l (N)	estimate		.1
NO3	mg/l (N)	estimate		.4
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.20
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.001
ALGAE(2)	mg/l	estimate		.005
ZOO	mg/l	estimate		.001
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Parameter		Source	Suwannee Creek River Mile 445.6 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	AWW	mean of grab samples	7.9
BOD5	mg/l	AWW	mean of grab samples	2.2
COLIF	col./100 ml	AWW	mean monthly	Aug. 7400 Sep. 4200 Oct. 560
DETRITUS	mg/l	estimate		3
NH3	mg/l (N)	AWW	mean of grab samples	0.30
NO3	mg/l (N)	AWW	mean of grab samples	0.70
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	AWW	mean of grab samples	0.10
TDS	mg/l	AWW	mean of grab samples	96
ALGAE(1)	mg/l	estimate		.04
ALGAE(2)	mg/l	estimate		.06
ZOO	mg/l	estimate		.01
PH		AWW	mean of grab samples	7.1
ALKA	mg/l ($CaCO_3$)	AWW	mean of grab samples	27

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Parameter		Source	Johns Creek River Mile 436.8 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		8
BOD5	mg/l	estimate		1
COLIF	col./100 ml	estimate		100
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		.1
NO3	mg/l (N)	estimate		.4
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	estimate		.20
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.02
ALGAE(2)	mg/l	estimate		.04
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3° F

INFLOW QUALITY

Chattahoochee Local
River Mile 432.2

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		8
BOD5	mg/l	estimate		1
COLIF	col./100 ml	estimate		100
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		.1
NO3	mg/l (N)	estimate		.4
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	estimate		.20
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.001
ALGAE(2)	mg/l	estimate		.005
ZOO	mg/l	estimate		.001
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3° F

INFLOW QUALITY

Big Creek
River Mile 424.9

Parameter		Source	Remarks	Quality
TEMP	°F	EPD	mean monthly	Aug. 71 Sep. 66 Oct. 59
OXY	mg/l	AWW	mean of grab samples	8.5
BOD5	mg/l	AWW	mean of grab samples	1.1
COLIF	col./100 ml	AWW	mean monthly	Aug. 3500 Sep. 2600 Oct. 2200
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	AWW	mean of grab samples	.08
NO3	mg/l (N)	AWW	mean of grab samples	0.45
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	AWW	mean of grab samples	0.17
TDS	mg/l	AWW	mean of grab samples	60
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.05
ZOO	mg/l	estimate		.008
PH		AWW	mean of grab samples	7.2
ALKA	mg/l ($CaCO_3$)	AWW	mean of grab samples	21

INFLOW QUALITY

Parameter		Source	Willeo Creek River Mile 422.7 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		6
BOD5	mg/l	estimate		20
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		10
NH3	mg/l (N)	estimate		1.00
NO3	mg/l (N)	estimate		0.50
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		1.00
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.06
ALGAE(2)	mg/l	estimate		.12
ZOO	mg/l	estimate		.02
PH		estimate		7.4
ALKA	mg/l ($CaCO_3$)	estimate		50

1/ daily air temperature minus 3° F

2/ estimates include waste discharges into tributary

INFLOW QUALITY

Parameter		Source	Sope Creek River Mile 416.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	AWW	mean of grab samples	7.7
BOD5	mg/l	AWW	mean of grab samples	15.9
COLIF	col./100 ml	AWW	mean monthly	Aug. 1600K 2/ Sep. 1195K Oct. 4.43K
DETRITUS	mg/l	estimate		5.1
NH3	mg/l (N)	AWW	mean of grab samples	1.62
NO3	mg/l (N)	AWW	mean of grab samples	.45
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	AWW	mean of grab samples	1.57
TDS	mg/l	AWW	mean of grab samples	109
ALGAE(1)	mg/l	estimate		.04
ALGAE(2)	mg/l	estimate		.06
ZOO	mg/l	estimate		.01
PH		AWW	mean of grab samples	7.4
ALKA	mg/l ($CaCO_3$)	AWW	mean of grab samples	43

1/ daily air temperature minus 3^{o} F

2/ K = 1000's

INFLOW QUALITY

Parameter		Source	Long Island Creek River Mile 412.2 Remarks	Quality
TEMP	°F	AWW	mean monthly	Aug. 72.5 Sep. 67.1 Oct. 53.6
OXY	mg/l	AWW	grab sample mean	8.7
BOD5	mg/l	AWW	grab sample mean	0.7
COLIF	col./100 ml	AWW	mean monthly	Aug. 4100 Sep. 550 Oct. 400
DETRITUS	mg/l	estimate		1.4
NH3	mg/l (N)	AWW	grab sample mean	.11
NO3	mg/l (N)	AWW	grab sample mean	.11
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	AWW	grab sample mean	.06
TDS	mg/l	AWW	grab sample mean	64
ALGAE(1)	mg/l	estimate		.030
ALGAE(2)	mg/l	estimate		.015
ZOO	mg/l	estimate		.005
PH		AWW	grab sample mean	7.4
ALKA	mg/l ($CaCO_3$)	AWW	grab sample mean	32

INFLOW QUALITY

Parameter		Source	Rottenwood Creek River Mile 411.9 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	AWW	mean of grab samples	9.2
BOD5	mg/l	AWW	mean of grab samples	1.8
COLIF	col./100 ml	AWW	mean monthly	Aug. 16.9K 2/ Sep. 12.5K Oct. 9.3K
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	AWW	mean of grab samples	.16
NO3	mg/l (N)	AWW	mean of grab samples	.29
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	AWW	mean of grab samples	.18
TDS	mg/l	AWW	mean of grab samples	69
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		0
PH		AWW	mean of grab samples	7.5
ALKA	mg/l ($CaCO_3$)	AWW	mean of grab samples	26

1/ daily air temperature minus 3^{o} F

2/ K = 1000's

INFLOW QUALITY

Parameter		Source	Peachtree Creek River Mile 408.1 Remarks	Quality
TEMP	°F	EPD	mean monthly	Aug. 78 Sep. 73 Oct. 64
OXY	mg/l	AWW, USGS	mean of grab samples	8.3
BOD5	mg/l	AWW, USGS	mean of grab samples	4.1
COLIF	col./100 ml	AWW	mean monthly	Aug. 20K 1/ Sep. 10K Oct. 4.6K
DETRITUS	mg/l	estimate		15
NH3	mg/l (N)	AWW, USGS	mean of grab samples	.13
NO3	mg/l (N)	AWW	mean of grab samples	.65
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	AWW, USGS	mean of grab samples	.06
TDS	mg/l	AWW	mean of grab samples	99
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		0
PH		AWW, USGS	mean of grab samples	7.4
ALKA	mg/l ($CaCO_3$)	AWW, USGS	mean of grab samples	41

1/ K = 1000's

INFLOW QUALITY

R.M. Clayton STP
River Mile 408.0

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	Plant records	mean	64
COLIF	col./100 ml	estimate		200
DETRITUS	mg/l	estimate		16
NH3	mg/l (N)	estimate		9
NO3	mg/l (N)	estimate		18
NO2	mg/l (N)	estimate		.05
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		.02
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ daily air temperature minus 3° F

INFLOW QUALITY

Parameter		Source	Chattahoochee River STP River Mile 408.0 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	Plant records	mean monthly	Aug. 5 Sep. 4 Oct. 7
COLIF	col./100 ml	estimate		Aug. 200 Sep. 7 Oct. 100
DETRITUS	mg/l	estimate		Aug. 2 Sep. 3 Oct. 5
NH3	mg/l (N)	estimate		9
NO3	mg/l (N)	estimate		18
NO2	mg/l (N)	estimate		.05
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		.02
PH		Plant records	mean monthly	Aug. 6.9 Sep. 6.7 Oct. 6.7
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Parameter		Source	Remarks	Quality
		Plants Atkinson - McDonough River Mile 407.0		
TEMP	°F	GP	GP plant capacity	1/
OXY	mg/l	estimate		2/
BOD5	mg/l			
COLIF	col./100 ml			
DETRITUS	mg/l			
NH3	mg/l (N)			
NO3	mg/l (N)			
NO2	mg/l (N)			
PO4	mg/l (P)			
TDS	mg/l			
ALGAE(1)	mg/l			
ALGAE(2)	mg/l			
ZOO	mg/l			
PH				
ALKA	mg/l ($CaCO_3$)			

1/ change between inflow and outflow temperature = 15.1° F

2/ all parameters except temperature are assumed equal to river quality

INFLOW QUALITY

Parameter		Source	Proctor Creek River Mile 405.0 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8
BOD5	mg/l	estimate		3
COLIF	col./100 ml	estimate		10,000
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	estimate		.20
NO3	mg/l (N)	estimate		0.30
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.20
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.040
ALGAE(2)	mg/l	estimate		.020
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		30

1/ daily air temperature minus 3° F

2/ estimates include waste discharges into tributary

INFLOW QUALITY

Parameter		Source	Nickajack Creek River Mile 403.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8
BOD5	mg/l	estimate		3
COLIF	col./100 ml	estimate		10,000
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	estimate		.20
NO3	mg/l (N)	estimate		0.30
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.20
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.040
ALGAE(2)	mg/l	estimate		.020
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		30

1/ daily air temperature minus 3^{0} F

2/ estimates include waste discharges into tributary

INFLOW QUALITY

Parameter		Source	Sandy Creek River Mile 403.1 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8
BOD5	mg/l	estimate		3
COLIF	col./100 ml	estimate		10,000
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	estimate		.20
NO3	mg/l (N)	estimate		0.30
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	estimate		.20
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.040
ALGAE(2)	mg/l	estimate		.020
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		30

1/ daily air temperature minus 3° F

2/ estimates include waste discharges into tributary

INFLOW QUALITY

Sandy Creek STP
River Mile 403.1

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	Plant records	mean	126
COLIF	col./100 ml	estimate		200
DETRITUS	mg/l	estimate		17
NH3	mg/l (N)	estimate		9
NO3	mg/l (N)	estimate		18
NO2	mg/l (N)	estimate		.05
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		.02
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Parameter		Source	South Cobb STP River Mile 401.3 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	Plant records	mean monthly	Aug. 15 Sep. 118 Oct. 26
COLIF	col./100 ml	Plant records	mean monthly	Aug. 7 Sep. 200 Oct. 7
DETRITUS	mg/l	Plant records	mean monthly	Aug. 2 Sep. 22 Oct. 5
NH3	mg/l (N)	estimate		9
NO3	mg/l (N)	estimate		18
NO2	mg/l (N)	estimate		.05
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		.02
PH		Plant records	mean	7.0
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Fulco STP
River Mile 400.6

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	Plant records	mean	300
COLIF	col./100 ml	estimate		1,000,000
DETRITUS	mg/l	Plant records	mean	34
NH3	mg/l (N)	estimate		50
NO3	mg/l (N)	estimate		.4
NO2	mg/l (N)	estimate		.10
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		0
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Utoy Creek
River Mile 399.0

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8
BOD5	mg/l	estimate		2
COLIF	col./100 ml	estimate		10,000
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	estimate		0.20
NO3	mg/l (N)	estimate		0.30
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.20
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.040
ALGAE(2)	mg/l	estimate		.020
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		30

1/ daily air temperature minus 3° F

2/ estimates include waste discharges into tributary

INFLOW QUALITY

Utoy Creek STP
River Mile 399.0

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	estimate		20
COLIF	col./100 ml	estimate		200
DETRITUS	mg/l	estimate		6
NH3	mg/l (N)	estimate		9
NO3	mg/l (N)	estimate		18
NO2	mg/l (N)	estimate		.05
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		.02
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ daily air temperature minus 3^{0} F

INFLOW QUALITY

Sweetwater Creek River Mile 396.2

Parameter		Source	Remarks	Quality
TEMP	°F	EPD	mean monthly	Aug 74 Sep 68 Oct 59
OXY	mg/l	USGS	mean of grab samples	6
BOD5	mg/l	USGS	mean of grab samples	3.6
COLIF	col./100 ml	USGS	mean of grab samples	7500
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	USGS	mean of grab samples	.20
NO3	mg/l (N)	USGS	mean of grab samples	.24
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	USGS	mean of grab samples	.17
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		0
PH		USGS	mean of grab samples	7
ALKA	mg/l ($CaCO_3$)	USGS	mean of grab samples	32

INFLOW QUALITY

Camp Creek
River Mile 391.2

Parameter		Source	Remarks	Quality
TEMP	°F	EPD	mean monthly (N. Fork Camp Cr.)	Aug 77 Sep 73 Oct 65
OXY	mg/l	estimate 1/		8
BOD5	mg/l	estimate		3
COLIF	col./100 ml	estimate		10,000
DETRITUS	mg/l	estimate		5
NH3	mg/l (N)	estimate		0.20
NO3	mg/l (N)	estimate		0.30
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.20
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.040
ALGAE(2)	mg/l	estimate		.020
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		30

1/ Estimates include waste discharges into tributary

INFLOW QUALITY

Parameter		Source	Camp Creek STP River Mile 391.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		0
BOD5	mg/l	estimate		50
COLIF	col./100 ml	estimate		200
DETRITUS	mg/l	estimate		13
NH3	mg/l (N)	estimate		9
NO3	mg/l (N)	estimate		18
NO2	mg/l (N)	estimate		.05
PO4	mg/l (P)	estimate		12
TDS	mg/l	estimate		250
ALGAE(1)	mg/l	estimate		0
ALGAE(2)	mg/l	estimate		0
ZOO	mg/l	estimate		.02
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		100

1/ Daily air temperature minus 3°F

INFLOW QUALITY

Parameter		Source	Anneewakee Creek River Mile 389.1 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate		8.0
BOD5	mg/l	estimate		3.0
COLIF	col./100 ml	estimate		10,000
DETRITUS	mg/l	estimate		5.0
NH3	mg/l (N)	estimate		0.20
NO3	mg/l (N)	estimate		0.30
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.20
TDS	mg/l	estimate		100
ALGAE(1)	mg/l	estimate		.040
ALGAE(2)	mg/l	estimate		.020
ZOO	mg/l	estimate		.006
PH		estimate		7.5
ALKA	mg/l ($CaCO_3$)	estimate		30

1/ Daily air temperature minus 3°F

INFLOW QUALITY

Parameter		Source	Bear Creek River Mile 382.7 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	est.2/		8.5
BOD5	mg/l	est.		1.5
COLIF	col./100 ml	est.		400
DETRITUS	mg/l	est.		1
NH3	mg/l (N)	est.		.01
NO3	mg/l (N)	est.		.20
NO2	mg/l (N)	est.		.01
PO4	mg/l (P)	est.		.02
TDS	mg/l	est.		50
ALGAE(1)	mg/l	est.		.03
ALGAE(2)	mg/l	est.		.02
ZOO	mg/l	est.		.005
PH		est.		7.2
ALKA	mg/l ($CaCO_3$)	est.		15

1/Daily air temperature minus 3°F

2/Estimates based on known average data for Dog River

INFLOW QUALITY

Parameter		Source	Dog River River Mile 382.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	USGS	mean of grab samples	8.6
BOD5	mg/l	USGS	mean of grab samples	1.4
COLIF	col./100 ml	USGS	mean of grab samples	390
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	USGS	mean of grab samples	0.01
NO3	mg/l (N)	USGS	mean of grab samples	0.17
NO2	mg/l (N)	USGS	mean of grab samples	0.01
PO4	mg/l (P)	USGS	mean of grab samples	0.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		USGS	mean of grab samples	7.2
ALKA	mg/l ($CaCO_3$)	USGS	mean of grab samples	15

1/ daily air temperature minus 3^{o} F

INFLOW QUALITY

Parameter		Source	Local River Mile 380.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8.5
BOD5	mg/l	estimate		1.5
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		.01
NO3	mg/l (N)	estimate		.20
NO2	mg/l (N)	estimate		.01
PO4	mg/l (P)	estimate		.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		estimate		7.2
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3^{o} F

2/ estimates based on known average data for Dog River

INFLOW QUALITY

Snake Creek
River Mile 369.3

Parameter		Source	Remarks	Quality
TEMP	°F	EPD	mean monthly	Aug. 74 Sep. 69 Oct. 62
OXY	mg/l	estimate 1/		8.5
BOD5	mg/l	estimate		1.5
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		0.01
NO3	mg/l (N)	estimate		0.20
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		estimate		7.2
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ estimates based on known average data for Dog River

INFLOW QUALITY

Parameter		Source	Plant Yates River Mile 365.5 Remarks	Quality
TEMP	°F	GP	Plant Capacity	1/
OXY	mg/l	estimate		2/
BOD5	mg/l			
COLIF	col./100 ml			
DETRITUS	mg/l			
NH3	mg/l (N)			
NO3	mg/l (N)			
NO2	mg/l (N)			
PO4	mg/l (P)			
TDS	mg/l			
ALGAE(1)	mg/l			
ALGAE(2)	mg/l			
ZOO	mg/l			
PH				
ALKA	mg/l ($CaCO_3$)			

1/ change between inflow and outflow temperature = 14.9° F

2/ all parameters except temperature are assumed equal to river quality

INFLOW QUALITY

Parameter		Source	Wahoo Creek River Mile 364.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8.5
BOD5	mg/l	estimate		1.5
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		0.01
NO3	mg/l (N)	estimate		0.20
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		estimate		7.2
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3^{o} F

2/ estimate based on known average data for Dog River

INFLOW QUALITY

Parameter		Source	Whooping Creek River Mile 358.3 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8.5
BOD5	mg/l	estimate		1.5
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		0.01
NO3	mg/l (N)	estimate		0.20
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		estimate		7.2
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3° F

2/ estimate based on known average data for Dog River

INFLOW QUALITY

Yellowdirt Creek
River Mile 356.2

Parameter		Source	Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8.5
BOD5	mg/l	estimate		1.5
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		0.01
NO3	mg/l (N)	estimate		0.20
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		estimate		7.2
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3^{o} F

2/ estimate based on known average data for Dog River

INFLOW QUALITY

Parameter		Source	Centralhatchee Creek River Mile 344.2 Remarks	Quality
TEMP	°F		time variant estimate	1/
OXY	mg/l	estimate 2/		8.5
BOD5	mg/l	estimate		1.5
COLIF	col./100 ml	estimate		400
DETRITUS	mg/l	estimate		1
NH3	mg/l (N)	estimate		0.01
NO3	mg/l (N)	estimate		0.20
NO2	mg/l (N)	estimate		0.01
PO4	mg/l (P)	estimate		0.02
TDS	mg/l	estimate		50
ALGAE(1)	mg/l	estimate		.03
ALGAE(2)	mg/l	estimate		.02
ZOO	mg/l	estimate		.005
PH		estimate		7.2
ALKA	mg/l ($CaCO_3$)	estimate		15

1/ daily air temperature minus 3^{o} F

2/ estimate based on known average data for Dog River

WITHDRAWAL DATA

Name	River Mile	Withdrawal (cfs)	
Gwinnett Intake	445.5	Aug.	14
		Sep.	14
		Oct.	15
Dekalb Intake	433.0	Aug.	92
		Sep.	86
		Oct.	94
Cobb Water Intake	418.1	Aug.	30
		Sep.	29
		Oct.	32
Atlanta Water Intake	408.2	Aug.	194
		Sep.	175
		Oct.	180

APPENDIX E

CALIBRATION AND APPLICATION OF STORM

APPENDIX E

CALIBRATION AND APPLICATION OF STORM

by

Jess Abbott[1]

I. INTRODUCTION

This appendix describes the calibration and application of STORM to the Atlanta Metropolitan area and vicinity. The model was used to generate storm water loadings which were used in assessments of water quality conditions in the Chattahoochee River.

II. STORM MODEL CONCEPTS

STORM is a continuous simulation model that can be used for prediction of the quantity and quality of storm water runoff. The quantity portion of the program was developed for the City of San Francisco by Water Resources Engineers, Inc. (WRE) of Walnut Creek, California. The Hydrologic Engineering Center (HEC) contracted in 1972 with WRE for addition of storm water quality computations. Since then the HEC has added other capabilities including snowmelt and land surface erosion computations and prespecified hydrographs. Resource Analysis, Inc., of Cambridge, Massachusetts, has recently added the capability to simulate the quantity and quality of dry weather sewage.

Wet weather surface runoff pollutographs can be predicted for individual historical (or synthetic) events. The model requires hydrological, land use, and water quality input data. The STORM pollutographs can be used as input for a receiving water assessment model.

Another portion of the output from STORM provides statistical information based on analysis of the precipitation record (10-30 years of hourly data). Statistics such as average annual runoff, average annual washoff of each pollutant, average annual overflow, and average annual pollutant overflow can be used to aid the selection of storage capacities and treatment rates required to achieve desired control of storm water runoff. These and other features of the model are discussed in detail in the users manual (reference 1).

III. CALIBRATION

STORM was calibrated on four small research watersheds in the Peachtree Creek basin to provide a basis for prediction of storm water loadings for the study area. The following table shows the land use makeup of each research watershed.

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[1]Jess Abbott, Research Hydraulic Engineer, The Hydrologic Engineering Center.

Watershed	Drainage Area (sq. mi.)	Land Use (%) SIN	MUL	COM	IND	OPEN
South Fork Peachtree Creek at Montreal Road	5.4	30	6	6	18	40
Tributary to North Fork Peachtree Creek at Drew Valley Road	2.9	90	0	0	10	0
Tributary to South Fork Peachtree Creek at Parkside Circle	1.2	40	13	15	3	29
Tributary to Nancy Creek at Plantation Lane	1.3	14	0	18	58	10

NOTE: Data from reference 2.

Rainfall and runoff data for the four watersheds were provided by the Atlanta office of the U. S. Geological Survey. The storm water quality data were reported in reference 2.

Quantity

The quantity calibration involved adjusting the pervious area runoff coefficient (CPERV) and the impervious area runoff coefficient (CIMP) for each basin so that the computed runoff most nearly matched the observed runoff. The values of CPERV and CIMP for the research watersheds were used for those basins in the study which had comparable land use patterns. CIMP is applied to the input hydrographs to arrive at the runoff rate from the impervious areas. The runoff rate from the impervious areas is used to "drive" the pollutant washoff equations. Tables E-1 through E-4 show comparisons between observed rainfall and runoff and computed runoff for all major storms that occurred during the period of July-November 1974.

Quality

Two important sets of coefficients regulate the quality of storm water runoff predicted by STORM. These are the dust and dirt accumulation rates for each land use and the pollutant fractions of the dust and dirt for each land use. These coefficients, which should normally be obtained by field sampling, were not available for this study. The quality calibration was based on adjustment of program default values for these coefficients so that the predicted masses and concentrations of pollutants most nearly matched those measured during selected runoff events from the four research watersheds. The default values were developed from a study done in Chicago (reference 3).

TABLE E-1

South Fork Peachtree Creek at Montreal Road

Date (1974)	Hours	Rain (In.)	Observed[1] Runoff (In.)	Computed[2] Runoff (In.)
19 July	16-22	.48	.06	.07
23 July	18-23	1.32	.09	.23
26-27 July	20-04	.15	.10	.03
1 August	19-24	.44	.03	.06
3 August	12-22	.81	.16	.13
7 August	16-24	2.56	.66	.48
14 August	13-21	.67	.09	.11
16-17 August	22-04	.45	.15	.07
18 August	14-22	.83	.13	.14
29 August	13-19	.45	.03	.07
29-30 August	19-04	.89	.20	.16
1 September	15-24	.53	.07	.07
2 September	16-22	.95	.24	.16
3 September	15-21	.08	.02	.01
14 September	11-16	.99	.09	.17
16 September	0-12	1.12	.16	.21
11 November	18-24	.79	.03	.15
18 November	3-6	.58	.02	.11
20 November	7-13	.55	.10	.09
TOTALS		14.64	2.54	2.52

1/ Surface runoff (obtained by manual separation of surface and base flow on hydrographs from U.S.G.S. gage records).

2/ Surface runoff computed by STORM

TABLE E-2

Tributary to North Fork Peachtree Creek at Drew Valley Road

Date (1974)	Hours	Rain (In.)	Observed[1/] Runoff (In.)	Computed[2/] Runoff (In.)
23 July	12-14	.13	.01	.01
1 August	19-20	.61	.06	.14
2 August	20-22	.53	.15	.14
3 August	12-15	1.01	.31	.26
7 August	16-21	2.74	.81	.74
11 August	19-22	.33	.16	.08
18 August	14-16	.23	.05	.04
29 August	19-21	.18	.14	.02
15-16 Sept.	22-06	1.19	.17	.32
11 November	16-20	.67	.12	.17
17 November	23-04	.61	.11	.15
TOTALS		7.63	1.99	2.07

1/, 2/ See notes Table E-1

TABLE E-3

Tributary of South Fork Peachtree Creek at Parkside Circle

Date (1974)	Hours	Rain (In.)	Observed[1/] Runoff (In.)	Computed[2/] Runoff (In.)
23 July	18-20	.93	.16	.21
1 August	19-21	.43	.04	.09
7 August	16-21	2.03	.46	.47
14 August	13-15	.82	.23	.18
16 August	22	.42	.19	.08
18 August	15	.68	.14	.17
29 August	14-21	.48	.23	.09
15-16 October	23-6	.91	.12	.22
11 November	16-20	.78	.10	.19
17 November	17-20	.41	.07	.10
20 November	7-9	.67	.14	.14
TOTALS		8.56	1.88	1.94

1/, 2/ See notes Table E-1

TABLE E-4

Tributary to Nancy Creek at Plantation Lane

(1974)	Hours	Rain (In.)	Observed[1/] Runoff (In.).	Computed[2/] Runoff (In.)
26 July	17-19	1.51	.34	.73
1 August	19-21	.41	.11	.16
2 August	20-22	.50	.29	.25
3 August	13-15	.81	.33	.38
11 August	20-21	.72	.12	.32
14 August	12-15	1.30	.50	.62
16 August	22-24	1.17	.22	.58
18 August	14-15	.83	.34	.38
29 August	18-20	.34	.25	.17
1 September	12-22	.51	.33	.21
15 October	22-6	1.26	1.07	.60
5 November	6-9	.48	.37	.20
11 November	17-20	.67	.45	.32
17 November	23-3	.63	.41	.27
20 November	6-10	.83	.53	.38
TOTALS		11.97	5.66	5.57

1/, 2/ See notes Table E-1

Certain other coefficients, which normally remain fixed, were modified for this study. The equations used to compute BOD, total nitrogen (TN) and total phosphorus (TP) are made up of three terms each, one term for the soluble contribution and two other terms for the insoluble contributions. (TP was the only form of phosphorus that was measured so the coefficients were also adjusted to predict TP instead of total orthophosphate.) The insoluble contributions are computed as fractions of both suspended solids (SUSP) and settleable solids (SETL). These fractions are not input variables and thus remain fixed unless the program is changed by the user. Since the measured data from each watershed showed very low BOD to suspended solids ratio the equations normally used in the model produced BOD values in excess of the measured values when suspended solids values were accurately predicted. The effect of reducing the soluble contribution to zero (i.e., BOD fraction of the dust and dirt) produced BOD values in excess of measured, therefore, it was justified to reduce the nonsoluble contributions. The revised nonsoluble contribution coefficients that were developed during calibration and used to generate the BOD, TN, and TP loadings for the river water quality model are shown below:

Parameter	Fraction of Suspended Solids	Fraction of Settleable Solids
BOD	0.01	0.002
TN	0.0025	0.0005
TP	0.002	0.0005

The following table shows dust and dirt accumulation rates and pollutant constituents of the dust and dirt that were developed during calibration.

Land Use	Dust and Dirt Accumulation Rate (lbs/100 ft. gutter/day)	Pollutant Constituents (lbs pollutant/100 lbs DD)				
		SUSP	SETL	BOD	TN	TP
Single	2.20	40.0	1.1	0.50	0.048	0.002
Multiple	6.90	32.0	0.8	0.36	0.061	0.002
Commercial	6.90	68.0	1.7	0.77	0.041	0.002
Industrial	13.30	68.0	0.7	0.30	0.043	0.001
Open	4.50	40.0	1.1	0.50	0.048	0.0002

The values do not necessarily make up a unique set, but rather are those that were judged to best reproduce the observed data from the four research watersheds. The calibration was based not only on reproduction of the time value of pollutant concentrations, but also on the total masses of pollutants washed off by the event. Montreal is the only basin where there exists more than one measured sample per storm (other than several composite samples on Plantation and Parkside). A single sample per storm precludes computing an a accurate observed pollutograph and therefore is of little value in calibration.

IV. APPLICATION OF STORM TO ATLANTA AND VICINITY

Input Data

The precipitation record is the primary input data set for STORM. Data were most readily available for the U.S. Weather Service station at the Atlanta Airport. Hourly precipitation was obtained on magnetic tape from the National Weather Service in Asheville, North Carolina. The data from the tape was processed, reformatted and placed in fast access storage in the Lawrence Berkeley Laboratory Computer System. STORM is capable of accessing this stored data so as to avoid handling a large amount of data in card form.

A representative sample of the twenty-five years of record was chosen so as to reduce computer time usage. The years 1970-1974 were chosen as representative based on equivalent average annual pollutant washoff. The STORM model has the capability of processing any portion of the precipitation record. The sample period was used to generate the pollutant loadings for the August-September 1974 Chattahoochee River study period.

Land use information makes up the second main block of input data. The storm water loadings generated represent 1975 land use conditions. The land use data was supplied by the Savannah District.

Storm Water Simulation

The storm water simulation consisted of dividing the entire study area into a number of subcatchments which would correspond to water quality loading points used in the river simulation. Twenty-five loading points were used along the study reach of the Chattahoochee River. Table E-5 shows the contents and land use of each of the subcatchments. The contributing area designation numbers were taken

Table E-5

Land Use for Subcatchments

River Mile	Contributing Areas from WQMU Map	Area (Acres)	Land Use Percentages 4/ SI	MU	CO	IN	OP
451.2	1205 A, 1206 A	20,893	4.6	0.1	0.4	0.4	94.5
445.6	1206 Ivy Creek, 1206 Suwannee Creek	33,357	4.0	0.1	0.4	0.4	95.1
436.8	1207 Johns Creek	20,196	2.9	.3	.2	0	96.6
432.2	1208 Chattahoochee I	29,568	10.8	.4	.5	2.2	86.1
424.9	1209 Big Creek 1/	32,442	7.2	.2	.5	.1	92.0
422.7	1210 Willeo Creek	16,384	8.8	.2	.5	.2	90.3
416.2	1211 Sope Creek	21,768	16.4	1.1	1.6	.9	80.1
411.9	1211 Central Cobb	22,493	18.9	2.5	2.9	5.7	70.0
403.2	1211 Nickajack Creek	23,910	25.4	1.3	1.4	2.0	69.9
412.2	1212 Long Island	14,651	42.3	2.5	1.8	.8	52.6
408.1	1212 Nancy Creek, 1212 Peachtree Creek, 1212 S. F. Peachtree Cr. 2/	83,394	36.3	5.8	5.3	4.7	47.9
405.0	1212 Proctor Creek	11,685	21.6	9.9	4.5	7.7	56.3
403.1	1213 A Sandy Creek	6,400	26.7	3.6	1.8	5.8	62.1
399.0	1213 Utoy Creek, 1213 B Sweetwater	26,557	26.7	3.6	1.8	5.8	62.1
396.2	1214 Olley Cr., Noses Cr., Powder Spr. Creek, Gothards Creek, Sweetwater Creek 3/	178,382	9.7	.2	.6	.5	89.0
391.2	1215 Camp Creek, 1215 Deep Creek	47,203	12.1	1.3	1.0	.6	85.0
389.1	1215 A, 1216 Anneewakee	28,673	5.6	.1	.4	.2	93.7
382.2	1217 Dog R., 1217 B	39,279	1.8	0	.1	.2	97.9
382.7	1217 A, 1218 Bear Cr., 1218 B	42,752	2.8	.1	.2	.1	96.8
380.2	1218 A	21,616	.9	0	.1	0	99.9
369.3	Snake Cr.	31,360	0.9	0	0.1	0	99.9
364.2	Wahoo Cr.	41,600	0.9	0	0.1	0	99.9
358.3	Whooping Cr.	34,560	0.9	0	0.1	0	99.9
356.2	Yellow Dirt Cr.	5,120	0.9	0	0.1	0	99.9
344.2	Centralhatchee Cr.	78,720	0.9	0	0.1	0	99.9

1/ Gaged, area above gage = 47,080 acres.

2/ Gaged, area above gage = 55,600 acres.

3/ Gaged, area above gage = 157,500 acres.

4/ 1975 Land Use Conditions.

from a Water Quality Management Unit Map supplied by the Savannah District.

The discharge hydrographs from each subcatchment were provided as input. The hydrographs were derived by stream routing optimizations using HEC-1 (as discussed earlier) and were judged to be more accurate than those produced by the runoff coefficient method in STORM. The option of prespecified hydrographs was then used to allow the STORM model to use the hydrographs in the washoff quality computations.

Efficient transfer of output from STORM required modifying STORM so that it would punch the flow and concentration data for each loading point on cards in a format that was directly useable by the WQRRS model.

V. DISCUSSION

The storm water loadings were judged to be fairly accurate but subject to several limitations caused by inadequate data for calibration and/or inaccurate input data. These limitations are discussed in the following paragraphs.

<u>Quantity</u>

The most serious limitation in the quantity of runoff computations was the low magnitude and yet highly variable observed runoff coefficient during the study period. The events experienced during the period were thunderstorms over quite dry summer-fall watershed conditions. The problem was partly alleviated by the use of input hydrographs that were developed by routing optimization using observed streamflow.

<u>Quality</u>

The quality calibration was somewhat inadequate because of total or partial lack of data on certain coefficients which regulate the quality of runoff.

No data were available for two very important sets of site-specific coefficients used in the model. These are the dust and dirt accumulation rates for each land use and the pollutant constituents of the dust and dirt for each land use.

The lack of the dust and dirt accumulation rates and the pollutant fractions required that the calibration be based entirely on the observed storm water runoff data from the four watersheds. The observed storm water runoff data was inadequate for development of a highly accurate calibration. Montreal Road was the only site for which there existed quality data for more than one grab sample during any given event although several composite samples were taken during

three events at Plantation and Parkside. Montreal had only three events with greater than four samples per event. Only one of these events had multiple samples during the actual "runoff" hydrograph.

VI. RECOMMENDATIONS

A well-designed data collection program should be implemented to collect data on the dust and dirt accumulation rates, the pollutant fractions of the dust and dirt, and additional storm water runoff data. It is recommended that the basins be of a single land use. Coefficients that are a function of land use can thus be defined. A representative segment of a street in each basin should be swept at appropriate intervals so as to estimate the dust and dirt accumulation rate for the specific land use. The dust and dirt should then be analyzed to obtain the fractions of the pollutants of interest.

It is imperative that additional storm water runoff data be collected so as to refine the coefficients which regulate the quantity and quality of runoff. A sampling program should be set up to collect sufficient data on several storms that occur throughout a year so as to adequately define the pollutographs for those events. This will probably involve use of some automatic sampling equipment in order to initiate sampling at the beginning of a significant rise in stage and continue sampling at frequent intervals throughout the event.

Some sampling stations should be located to better define the downtown Atlanta commercial/industrial contribution. It is believed that these basins would show higher loads than the basins previously sampled.

The calibration should be reevaluated using the new data recommended by the above paragraphs. If the calibration coefficients are significantly different than that developed during this study, part of the river water quality assessment should be reevaluated so as to better define the true impact of storm water runoff on the Chattahoochee River.

References (Appendix E)

1. The Hydrologic Engineering Center, Urban Storm Water Runoff (STORM) Generalized Computer Program 723-S8-L2520, August 1975.

2. Black, Crow and Eidness Inc. and Jordan Jones, & Goulding, Inc. Non Point Pollution Evaluation, Atlanta Urban Area. May 1975.

3. Federal Water Pollution Control Administration, Water Pollution Aspects of Urban Runoff, January 1969.

APPENDIX F

PHYSICAL, CHEMICAL AND BIOLOGICAL RATE COEFFICIENTS

APPENDIX F

PHYSICAL, CHEMICAL AND BIOLOGICAL RATE COEFFICIENTS

General

With the exception of the conservative constituents (i.e., alkalinity and TDS), all the water quality equations incorporate one or more physical, chemical or biological coefficients. Most of these coefficients are based upon an empirical understanding of a process. For example, the BOD decay rate is a simplified description of a complex bacterial action. Thus, values for many of the coefficients can be variable depending upon such factors as regional climatic variation, general levels of pollution, treatment, and industry.

Table F-1 lists the coefficients* used in this study.

Temperature Coefficients

The Q10 temperature coefficients for coliform and reaeration are used to adjust the rate coefficients to reflect changes in temperature by the following general expression

$$K = K_2\theta^{(T-20)} \qquad \text{F-1}$$

where

K = Coliform decay or reaeration rate coefficient at the local temperature

*These values are obtained in general from reference 16, but judgement and experience have also been taken into account in establishing these coefficients.

TABLE F-1

COEFFICIENTS

Q10 Temperature Coefficients

COLIFORM DIEOFF	1.040
REAERATION	1.022

Chemical Composition of Biota and Detritus

	C	N	P
ALGAE	.5	.09	.012
ZOOPLANKTON	.5	.09	.012
FISH	.5	.09	.012
BENTHO	.5	.09	.012
DETRITUS	.5	.09	.012

Digestive Efficiency of Biota

ZOOPLANKTON	.7
FISH	.6
BENTHO	.4

Stoichiometric Equivalence of Chemical and Biologic Transformation

O_2/NH_3 DECAY	3.5
O_2/NO_2 DECAY	1.2
O_2/DETRITUS DECAY	2.0
O_2/BIOMASS RESPIRATION	2.0
CO_2/BOD DECAY	0.2
O_2/ALGAL GROWTH*	1.6

*Oxygenation factor for Phytoplankton

TABLE F-1 (cont'd)

COEFFICIENTS

Temperature Limits		(°C)			K Factors	
	T_1	T_2	T_3	T_4	K_1	K_4
ALGAE 1	5	22	25	34	.1	.1
ALGAE 2	10	28	30	40	.1	.1
ZOOPLANKTON	5	28	30	38	.1	.1
BENTHO	5	22	25	38	.1	.1
FISH 1	5	20	20	25	.1	.1
FISH 2	10	27	30	38	.1	.1
FISH 3	5	22	30	36	.1	.1
BOD	4	30			.1	-
NH_3-N	4	30			.1	-
NO_2-N	4	30			.1	-
DETRITUS	4	30			.1	-

Settling Rate

	(M/Day)
ALGAE 1	.15
ALGAE 2	.15
DETRITUS	.15

Zooplankton Feeding Preference

For ALGAE 1 as a fraction of 1 .67

Mortality Rates

	(Rate/Day)
ZOOPLANKTON	.005
FISH	.001
BENTHO	.001

TABLE F-1 (cont'd)

COEFFICIENTS

Maximum Specific Growth Rates/Day

ALGAE 1	1.00
ALGAE 2	2.00
ZOOPLANKTON	.150
FISH 1	.020
FISH 2	.025
FISH 3	.020
BENTHO	.020

Half Saturation Constants of Phytoplankton

	Light	CO_2	N	P
ALGAE 1	.003	.02	.2	.03
ALGAE 2	.005	.02	.1	.05

Half Saturation Constants

ZOOPLANKTON	graze on ALGAE	.55
FISH 1	graze on ZOOPLANKTON	.05
FISH 2	graze on ZOOPLANKTON	.05
FISH 3	graze on BENTHO	500
BENTHO	graze on SEDMT	50

Decay Coefficients/Day

BOD	.100
AMMONIA	1.00
NITRITE	3.00
DETRITUS	.001
COLIFORM	.500

TABLE F-1 (cont'd)

COEFFICIENTS

Respiration Rates

	(Rate/Day)
PHYTOPLANKTON	.050
ZOOPLANKTON	.020
FISH	.001
BENTHO	.001

K_2 = Coliform decay or reaeration rate coefficient at 20°C

θ = Q10 temperature coefficient

T = Local temperature

By using the temperature coefficient concept, the decay or reaeration rate coefficients can be specified for a common temperature (20°C) and automatically adjusted within the program for temperature differences. These Q10 coefficients are only of real concern for temperatures greater than 30°C or less than 10°C and may thus be treated as constants during the calibration process, unless specific evidence to the contrary is available.

Chemical Composition of Biota and Detritus

The chemical composition data are used to maintain continuity of mass within the system by removing an appropriate amount of a particular constituent with biota growth and returning mass due to biota respiration and detritus decay. Unfortunately, exact continuity of mass will not be maintained unless the composition of all the constituents are the same, because all biota contribute to detritus on a one to one basis.

Digestive Efficiency of Biota

The digestive efficiency is that fraction of the food consumed by biota which is utilized for growth. The remainder is used for metabolic processes (i.e., respiration and excretion).

Stoichiometric Equivalences

Stoichiometric equivalence is the ratio of the amount of two constituents needed for a given chemical or biologic reaction. For example, 3.5 grams of oxygen are consumed when one gram of ammonia nitrogen is oxidized to nitrite.

Temperature Limits

The temperature limits define the curves used to modify the growth, respiration, and mortality rates of the biota and the decay rates of the abiotic substances. The temperatures, T_1 and T_4, are the lower and upper threshold limits, respectively, for growth or decay. The temperatures T_2 and T_3 define the range at which the growth or decay rate is a maximum. If the maximum rate occurs at a single temperature, $T_2 = T_3$. T_3 and T_4 have no significance for abiotic substances.

Settling Rates

The settling rate defines the rate of fall of algae and detritus through the water column. It is of particular significance in the reservoir section where the algae and detritus may settle through hundreds of meters.

Zooplankton Feeding Preferences

The zooplankton feeding preference is used to establish an effective algae concentration for determining the zooplankton growth rate. This allows input of only one half saturation constant for zooplankton growth based on algae 1 and adjustment of the concentration of algae accordingly.

Mortality Rates

The mortality rate is that fraction of the biomass which is converted to detritus by death of the particular biota. The rate coefficients for mortality and respiration are in 1/day units and are utilized in the following general natural logarithmic function

$$C(t + \Delta t) = C_t e^{(k\Delta t)} \qquad \text{F-2}$$

where

$C(t + \Delta t)$ = Concentration at the end of the time step

C_t = Concentration at the beginning of the time step

K = Mortality or respiration rate

Δt = Computational time step

Note that mortality for algae is incorporated directly into respiration and algae are assumed to become sediment when they settle to the bottom of a stream or reservoir. The mortality rate coefficients are modified by the temperature limit coefficients and two exponential curves.

Respiration Rates

The respiration rate is that fraction of the biomass which is converted back to inorganic carbon, nitrogen and phosphorus by the normal process of respiration of the organism. The respiration rate coefficients are modified by the temperature limit coefficients and two exponential curves.

Maximum Specific Growth Rates

The maximum specific growth rate is the maximum fractional increase in biomass which can occur without any nutrient limiting. The maximum growth rate and the decay rate coefficients are modified by the temperature limit coefficients and one or more exponential curves.

Half Saturation Constants

The half saturation constants or Michaelis-Menton constants are used to adjust the growth rate of the biota to the available nutrient or food supply. The half saturation constant is actually the concentration of the nutrient at which the biota will grow at half the maximum rate. The following expression is used to adjust the growth rates:

$$\mu = \mu_m \left(\frac{C}{K+C}\right) \qquad \text{F-3}$$

where

μ = Actual growth rate

μ_m = Maximum growth rate

C = Nutrient concentration

K = Half saturation constant

Decay Rates

The decay rate is that fraction of the constituent which is removed or converted into other constituents by bacterial or chemical decomposition. In some cases this decay is dependent on the presence of oxygen; for example, BOD, NH_3 and NO_2 decay may generally be considered as aerobic reactions. However, decay of sediments and detritus may be either aerobic or anaerobic with different decay rates for each type. Such refinements are not presently incorporated into the model, although oxygen dependent reactions are programmed to be inhibited by a lack of available oxygen.

APPENDIX G

GEORGIA WATER QUALITY STANDARDS

Table of Contents

rules and regulations for water quality control

Chapter 391-3-6
Revised
June, 1974

Georgia Department of
NATURAL RESOURCES

Environmental Protection Division
47 Trinity Avenue, S.W.
Atlanta Georgia 30334

RULES
OF
GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

CHAPTER 391-3-6
WATER QUALITY CONTROL

TABLE OF CONTENTS

391-3-6-.01 Organization and Administration.

(1) **Purpose.** The purpose of Paragraph 391-3-6-.01 is to establish the organizational and administrative procedures to be followed in the administration and enforcement of the Georgia Water Quality Control Act, as amended, and to carry out the purposes and requirements of said Act and of the Federal Water Pollution Control Act Amendments of 1972, as amended.

(2) **Definitions.** All terms used in this Paragraph shall be interpreted in accordance with the definitions as set forth in the Georgia Water Quality Control Act, as amended, unless otherwise defined in this Paragraph or in any other Paragraph of these rules:

(a) "Act" means the Georgia Water Quality Control Act, as amended.

(b) "Board" means the Board of Natural Resources of the State of Georgia.

(c) "Department" means the Department of Natural Resources of the State of Georgia.

(d) "Director" means the Director of the Division of Environmental Protection of the Department of Natural Resources, State of Georgia.

(e) "Division" means the Division of Environmental Protection of the Department of Natural Resources, State of Georgia.

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(f) "E.P.A." means the United States Environmental Protection Agency.

(g) "Federal Act" means the Federal Water Pollution Control Act Amendments of 1972, as amended.

(h) "National Pollutant Discharge Elimination System" (NPDES) means the national system for the issuance of permits under Section 402 of the Federal Water Pollution Control Act Amendments of 1972.

(i) "Regional Administrator" means the Regional Administrator for the EPA region which includes the State of Georgia.

(3) **Organization.** The Division of Environmental Protection of the Department of Natural Resources is responsible for enforcing those environmental protection laws of the State of Georgia as specified in the Executive Reorganization Act of 1972, as amended. Requests for information and submission of materials should be made to the Division office.

(4) **Administrative Hearings.**

(a) Hearings may be held in accordance with the Act in connection with the following matters:

1. To determine whether or not an alleged pollution is contrary to the public interest.

2. In connection with the securing, within the time specified by order or permit of the Director, of such operating results as are reasonable and practicable of attainment toward the control, abatement or prevention of pollution of the waters of the State and the preservation of the necessary quality for the reasonable use thereof.

3. In connection with notice to the holder of a permit of intent to revoke, suspend, or modify the permit.

4. In connection with the refusal of any person to cooperate with the efforts of the Division to reduce pollution, and upon the issuance of an order by the Director, to bring about the reduction or elimination of pollution within a reasonable time.

5. Any person who is aggrieved or adversely affected by any order or action of the Director and who petitions the Director for

a hearing within thirty (30) days of the issuance of such order or notice of such action. Such person shall be granted a hearing before a hearing officer appointed by the Board of Natural Resources. The initial hearing and any administrative review thereof shall be conducted in accordance with Section 17(a) of the Executive Reorganization Act of 1972, as amended.

6. Any person against whom an emergency order is directed, provided such person petitions the Director for a hearing within the thirty (30) days of the issuance of such order. Such person shall be afforded a hearing as soon as possible.

7. In connection with public hearings required pursuant to Section 402(b) (3) of the Federal Act and Federal Regulations, 40 C.F.R. 124.36.

8. In connection with public hearings or public participation required pursuant to Section 101(e) of the Federal Act.

(b) Insofar as applicable to the administrative procedures required pursuant to the Georgia Water Quality Control Act, as amended, Sections 14, 15, 16, 17, and 18 of the Georgia Administrative Procedure Act, as amended, and Section 17(a) of the Executive Reorganization Act of 1972, as amended, shall apply.

(5) **Notice.** Notice of all hearings provided for above shall be issued in accordance with Section 14 of the Georgia Administrative Procedure Act, as amended, and Federal Regulations, 40 C.F.R. 124.37.

(6) **Notice to File Plan of Correction or Improvement.**

(a) In order to carry out a comprehensive plan to prevent and control pollution, the Division, as required by Section 5 of the Act and Section 303 of the Federal Act, may conduct studies and perform evaluations to determine waste load allocations in order to specify the degree of treatment and or technology necessary to achieve the established effluent limitations; the maintenance of existing wastewater treatment technology, supplementary treatment or other specific measures necessary to attain and maintain applicable water quality standards, and protect the down stream users; or such other measures necessary to prevent further pollution or reduce existing pollution. Upon the establishment of the necessary corrective action, the discharger will be required to file a plan and schedule of improvement with the Division. The Director

may issue a notice to any person to submit within a specified time a plan of improvement and schedule for compliance with the specified requirements.

(b) The Director is authorized to approve plans, specifications, and related material, and to issue permits on behalf of the Division to persons who apply for such permits in accordance with Section 10 of the Act and such rules as are adopted and promulgated pursuant to same.

(7) ***Effective Date.*** This Paragraph shall become effective on June 30, 1974.

Authority Ga. Laws 1964, p. 416, as amended; Ga. Laws 1972, p. 1015, as amended. Effective June 30, 1974. ***Administrative History.*** Original Rule was filed on June 10, 1974, effective June 30, 1974.

391-3-6-.02 Preparation and Submission of Engineering Reports and Plans and Specifications.

(1) **Purpose.** The purpose of Paragraph 391-3-6-.02 is to establish procedures to be followed by persons submitting to the Division engineering reports, plans and specifications, and related materials for the construction of any system for the disposal or treatment of pollutants.

(2) **Definitions.** All terms used in this Paragraph shall be interpreted in accordance with the definitions as set forth in the Act, unless otherwise defined in this Paragraph or in any other Paragraph of these Rules:

(a) "Professional Engineer." A person registered to practice professional engineering in accordance with the provisions of an Act Governing the Practice of Professional Engineering in Georgia (Ga. L. 1945, p. 294, as amended; Ga. Code Section 84-2100).

(b) "Owner." Any person owning or operating any system for the disposal or treatment of pollutants.

(c) "Sewerage System" means any system for the treatment or disposal of pollutants including treatment works, pipe lines or conduits, pumping stations and force mains, and all other constructions, devices, and appliances appurtenant thereto, used for conducting pollutants to the point of ultimate disposal.

(3) ***General Provisions.***

(a) Any person who desires to erect, modify, or alter a sewerage

system shall obtain approval of any plans, specifications and related materials for such system from the Division prior to commencement of construction.

(b) Engineering material submitted to the Division shall be prepared by a Professional Engineer competent in the treatment of water pollutants.

(c) During the early stages of planning for the construction of a sewerage system, and prior to the formal submission of an application and accompanying materials for any permit required pursuant to the Act, or materials submitted for Division approval pursuant to these rules, a conference between the project owner or his representative and representatives of the Division shall be held at the request of either the Director or the project owner, in order to reach a clear understanding of the proposal to be formally submitted to the Division at a later time. Such conference shall be granted within sixty (60) days after a written request to the Division by the project owner or his representative. If a conference is not granted within such period, then such permit application or other materials shall be filed and acted upon by the Division after the expiration of such period.

(d) Sufficient copies of completed reports, plans and specifications, and related materials shall be submitted to the Division to cover necessary distribution when approved. Such material, accompanied by a letter of transmittal, shall be submitted by the project owner or his representative well in advance of any critical date involved, in order that time will be available for review, discussion and revision when necessary. The submittal of such material shall be complete, accurate, distinct, legible, and relevant in respect to the project to which it applies. Permit applications shall be processed as provided in Paragraph 391-3-6-.06.

(e) Plans for a sewerage system submitted to the Division will be considered for approval by the Division only when designed so as to minimize the passage of rainwater from roofs, streets or other areas and all groundwater, other than unavoidable infiltration, through such sewerage system.

(f) All proposed lift stations must be approved by the Division.

(4) **Engineering Reports.** Engineering reports submitted to the Division shall contain a comprehensive description of the proposed project and shall include the following:

(a) Pertinent information regarding the existing sewerage system, if applicable;

(b) Characteristics of existing pollutants and existing or proposed treatment of such pollutants;

(c) Demonstration of the need for the proposed sewerage system;

(d) Evaluation of alternatives to define the most cost effective method for meeting established effluent limitations, water quality goals, and treatment requirements;

(e) Results to be expected from treatment process;

(f) Sufficient maps, charts, tables, calculations, basis of design data and graphs to make the report readily understandable;

(g) An operation and maintenance program description;

(h) Such other pertinent engineering information as the Division may require.

(5) **Plans and Specifications.** Plans and specifications submitted to the Division for a sewerage system shall include the following:

(a) A map showing the area to be served by the sewerage system;

(b) Profiles of proposed sewers;

(c) Construction details of manholes and other special sewer structures;

(d) General and detail plans for the treatment facility;

(e) Complete design data for the treatment facility plans, to be submitted in duplicate on forms specified by the Division;

(f) Specifications for the construction of the sewerage system;

(g) Such other plans and specifications as the Division may require.

(6) **General Map Plans.** General map plans submitted to the

Division for a sewerage system shall include the following:

(a) A map plan that shows the entire area to be served, drawn to a scale of from 100 to 300 feet per inch. The map plan may be divided into sections, provided the sheets are bound together and indexed to show the area covered by each sheet.

(b) All existing and proposed streets in the area to be served; surface elevations at all street intersections; the location of all existing sewers, separate or combined; the location of the treatment facility; the location of the existing and proposed sewer outlets or overflows; the elevation of the highest known stream water level at the outlets and the treatment facility; and clear identification of any areas from which sewage is to be pumped.

(c) Clear designation on the plan by suitable symbols of all sewer appurtenances, including, but not limited to, manholes, siphons and pumps.

(d) Such other information as the Division may require.

(7) **Sewer Plans and Profiles.** Sewer plans and profiles submitted to the Division for a sewerage system shall include the following:

(a) Sewers and force mains, drawn at a scale that shows the profile for all manholes, siphons, railroad crossings, street or stream crossings, elevations of stream beds, normal stream water levels, and sizes and grades of sewers which show surface elevations and sewer invert elevations.

(b) Detailed drawings of all sewer appurtenances, including, but not limited to, manholes, inspection chambers, siphons, lift stations, and any special structures to accompany the sewer plans. Detailed drawings shall be to a scale suitable to clearly show the design details.

(8) **Treatment Facilities Plans.** Plans for treatment facilities submitted to the Division shall include the following:

(a) A general plan that clearly identifies the exact location of the facilities, areas reserved for future expansion, access roads to the various units, and the point at which the access roads connect with existing road or street systems. It shall also show sufficient detail of the units, pipelines or any other features so as to make the proposed treatment process clearly and easily understood. The

elevations of all units and water surfaces shall be shown.

(b) **Detail plans** which show longitudinal and transverse sections sufficient to explain the construction of each treatment unit.

(c) **Flow measuring devices** at appropriate points in the plan. Sampling and recording devices may be required by the Division when deemed necessary.

(d) Such other information as the Division may require.

(9) **Approval of Plans and Specifications.** Approval of the plans and specifications by the Division does not include or imply approval of the structural, electrical, or mechanical integrity of the sewerage system, treatment facilities, units or equipment.

(10) **Deviation from Approved Plans and Specifications.** No deviations from approved plans and specifications shall be made during construction unless documentation showing proposed changes has been submitted to and approved by the Division.

(11) **Effective Date.** This Paragraph shall become effective on June 30, 1974.
Authority Ga. Laws 1964, p. 416, as amended. Effective June 30, 1974 **Administrative History.** Original Rule was filed on June 10, 1974; effective June 30 1974

391-3-6-.03 Water Use Classifications and Water Quality Standards.*

(1) **Purpose.** The establishment of water quality standards.

(2) **Water Quality Enhancement:**

(a) The purposes and intent of the State in establishing Water Quality Standards are to provide enhancement of water quality and prevention of pollution; to protect the public health or welfare in accordance with the public interest for drinking water supplies, conservation of fish, game and other beneficial aquatic life, and agricultural, industrial, recreational, and other beneficial uses.

(b) Those waters in the State whose existing quality is better than the minimum levels established in standards on the date standards become effective will be maintained at high quality; with the State having the power to authorize new developments, when

*Applicable to Intrastate and Interstate Waters of Georgia

it has been affirmatively demonstrated to the State that a change is justifiable to provide necessary social or economic development; and provided further that the level of treatment required is the highest and best practicable under existing technology to protect existing beneficial water uses.

(c) In applying these policies and requirements, the State of Georgia will recognize and protect the interest of the Federal Government in interstate (including coastal and estuarine) waters. Toward this end the State will consult and cooperate with the Environmental Protection Agency on all matters affecting the Federal interest.

(3) **Definitions.** All terms used in this Paragraph shall be interpreted in accordance with definitions as set forth in the Act and as otherwise herein defined:

(a) "Reasonable and necessary uses" means drinking water supplies, conservation of fish, game and other aquatic life, agricultural, industrial, recreational, and other legitimate uses.

(b) "Shellfish" refers to clams, oysters, scallops, mussels, and other mollusks.

(c) "Intake temperature" is the natural or background temperature of a particular waterbody unaffected by any man-made discharge or thermal input.

(d) "Coastal waters" are those littoral recreational waters on the ocean side of the Georgia coast.

(4) **Water Use Classifications.** Water use classifications for which the criteria of this Paragraph are applicable are as follows:

(a) Drinking Water Supplies

(b) Recreation

(c) Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life

(d) Agricultural

(e) Industrial

(f) Navigation

(g) Wild River

(h) Scenic River

(i) Urban Stream

(5) **General Criteria for All Waters.** The following criteria are deemed to be necessary and applicable to all waters of the State:

(a) All waters shall be free from materials associated with municipal or domestic sewage, industrial waste or any other waste which will settle to form sludge deposits that become putrescent, unsightly or otherwise objectionable.

(b) All waters shall be free from oil, scum and floating debris associated with municipal or domestic sewage, industrial waste or other discharges in amounts sufficient to be unsightly or to interfere with legitimate water uses.

(c) All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.

(d) All waters shall be free from toxic, corrosive, acidic and caustic substances discharged from municipalities, industries or other sources in amounts, concentrations or combinations which are harmful to humans, animals or aquatic life.

(e) Applicable State and Federal requirements and regulations for the discharge of radioactive substances shall be met at all times.

(f) No man-made physical or other alteration of stream beds that may violate established water quality standards, or reduce the waste assimilative capacity of the streams, will be permitted without the expressed approval of the Environmental Protection Division.

(6) **Specific Criteria for Classified Water Usage.** The following criteria are deemed necessary and shall be required for the specific water usage as shown:

(a) Drinking Water Supplies:

1. Those waters approved by the Environmental Protection Division and requiring only approved disinfection and meeting the requirements of the Federal Drinking Water Standards; or waters approved by the Environmental Protection Division for human consumption and food-processing or for any other use requiring water of a lower quality:

(i) Bacteria: Fecal coliform not to exceed a geometric mean of 50 per 100 ml based on at least four samples taken over a 30-day period and not to exceed 200 per 100 ml in more than five percent of the samples in any 90-day period.

(ii) Floating solids, settleable solids, sludge deposits or any taste, odor or color producing substances: None associated with any waste discharge.

(iii) Sewage, industrial or other wastes: None.

2. Those raw water supplies requiring approved treatment to meet the requirements of the Environmental Protection Division and the Federal Drinking Water Standards or which are approved by the Environmental Protection Division for human consumption and food-processing; or for any other use requiring water of a lower quality:

(i) Bacteria: Fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples taken over a 30-day period and not to exceed a maximum of 4,000 per 100 ml.

(ii) Dissolved Oxygen: A daily average of 6.0 mg/1 and no less than 5.0 mg/1 at all times for waters designated as trout streams by the State Game and Fish Division. A daily average of 5.0 mg/1 and no less than 4.0 mg/1 at all times for water supporting warm water species of fish.

(iii) pH: Within the range of 6.0 - 8.5.

(iv) No material or substance in such concentration that, after treatment, would exceed the requirements of the Environmental Protection Division and the latest edition of Federal Drinking Water Standards.

(v) Temperature: Not to exceed 90°F. At no time is the temperature of the receiving waters to be increased more than 5°F above intake temperature except that in estuarine waters the increase

will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperature.

(b) Recreation:

1. General recreational activities such as water skiing, boating, and swimming, or for any other use requiring water of a lower quality. These criteria are not to be interpreted as condoning water contact sports in proximity to sewage or industrial waste discharges regardless of treatment requirements:

(i) Bacteria: Fecal coliform not to exceed a geometric mean of:

(I) Coastal Waters	- 100 per 100 ml
(II) All other recreational waters	- 200 per 100 ml

(III) Should water quality and sanitary studies show natural fecal coliform levels exceed 200/100 ml (geometric mean) occasionally in high quality recreational waters, then the allowable geometric mean fecal coliform level shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing fresh water streams.

I. The geometric mean will be used as the method of criteria expression. This technique will be applied to no less than four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours.

(ii) Dissolved Oxygen: A daily average of 6.0 mg/1 and no less than 5.0 mg/1 at all times for waters designated as trout streams by the State Game and Fish Division. A daily average of 5.0 mg/1 and no less than 4.0 mg/1 at all times for waters supporting warm water species of fish.

(iii) pH: Within the range of 6.0 - 8.5.

(iv) Toxic Wastes, Other Deleterious Materials: None in concentrations that would harm man, fish and game or other beneficial aquatic life.

(v) Temperature: Not to exceed 90°F. At no time is the temperature of the receiving waters to be increased more than 5°F above intake temperature except that in estuarine waters the increase

will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperatures.

(c) Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life; or for any other use requiring water of a lower quality:

1. Dissolved Oxygen: A daily average of 6.0 mg/1 and no less than 5.0 mg/1 at all times for waters designated as trout streams by the State Game and Fish Division. A daily average of 5.0 mg/1 and no less than 4.0 mg/1 at all times for waters supporting warm water species of fish.

2. pH: Within the range of 6.0 - 8.5.

3. Bacteria: Fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples taken over a 30-day period and not exceed a maximum of 4,000 per 100 ml.

4. Bacteria: (Applicable only to waters designated as approved shellfish harvesting waters by the appropriate State agencies) The requirements will be consistent with those established by the State and Federal agencies responsible for the National Shellfish Sanitation Program.

5. Temperature: Not to exceed 90°F. At no time is the temperature of the receiving waters to be increased more than 5°F above intake temperature except that in estuarine waters the increase will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperatures.

6. Toxic Wastes, Other Deleterious Materials: None in concentrations that would harm man, fish and game or other beneficial aquatic life.

(d) Agricultural:

1. For general agricultural uses such as stock watering and irrigating; or for any other use requiring water of a lower quality:

(i) Bacteria: Fecal coliform not to exceed a geometric mean of 5,000 per 100 ml based on at least four samples taken over a 30-day period.

(ii) Dissolved Oxygen: No less than 3.0 mg/1 at any time.

(iii) pH: Within the range of 6.0 - 8.5.

(iv) Temperature: Not to exceed 90°F. At no time is the temperature of the receiving waters to be increased more than 5°F above intake temperature except that in estuarine waters the increase will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperatures.

(v) Toxic Substances, Other Deleterious Materials: None in concentrations that would interfere with or adversely affect uses for general agricultural purposes or would prevent fish survival.

(e) Industrial:

1. For processing and cooling water with or without special treatment; or for any other use requiring water of a lower quality:

(i) Dissolved Oxygen: No less than 3.0 mg/1 at any time.

(ii) pH: Within the range of 6.0 - 8.5.

(iii) Toxic Substances, Other Deleterious Materials: None in concentrations that would prevent fish survival or interfere with legitimate and benefical industrial uses.

(iv) Temperature: Not to exceed 90°F. At no time is the temperature of the receiving waters to be increased more than 5°F above intake temperature except that in estuarine waters the increase will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperatures.

(f) Navigation:

1. To provide for commercial ship traffic and protection of seamen or crews:

(i) Bacteria: *Fecal coliform not to exceed a geometric mean of* 5,000 per 100 ml based on at least four samples taken over a 30-day period.

(ii) Dissolved Oxygen: No less than 3.0 mg 1 at any time.

(iii) pH: Within the range of 6.0 - 8.5.

(iv) Toxic Substances, Other Deleterious Materials: None in concentrations that would damage vessels, prevent fish survival or otherwise interfere with commercial navigation.

(v) Temperature: Not to exceed 90 F. At no time is the temperature of the receiving waters to be increased more than 5°F above intake temperature except that in estuarine waters the increase will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperatures.

(g) Wild River:

1. This classification will be applicable to any waters of the State when so designated by an authorized State or Federal Agency and will be effective simultaneously with that Agency's proper designation.

2. For all waters designated as "Wild River," there shall be no alteration of natural water quality from any source.

(h) Scenic River:

1. This classification will be applicable to any waters of the State when so designated by an authorized State or Federal Agency and will be effective simultaneously with that Agency's proper designation.

2. For all waters designated as "Scenic River," there shall be no alteration of natural water quality from any source.

(i) Urban Stream:

1. This classification is applicable to streams in highly developed urban areas:

(i) *All conditions specified under* **"General Criteria for All Waters"** [391-3-6-.03(5)] will apply, and in addition, the waters so classified are to be aesthetically compatible to adjacent areas.

(ii) **Bacteria**: Fecal coliform not to exceed a geometric mean of 2,000 per 100 ml based on at least four samples taken over a 30-day period and not to exceed a maximum of 5,000 per 100 ml.

(iii) pH: Within the range of 6.0 - 8.5.

(iv) Dissolved Oxygen: No less than 3.0 mg/1 at any time.

(7) **Natural Water Quality.** It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein.

(8) **Treatment Requirements.** Not withstanding the above criteria, the requirements of the State relating to secondary or equivalent treatment of all waste shall prevail. The adoption of these criteria shall in no way preempt the treatment requirements.

(9) **Streamflows.** Specific criteria or standards set for the various parameters apply to all flows on regulated streams. On unregulated streams, they shall apply to all streamflows equal to or exceeding to 7-day, 10-year minimum flow.

(10) **Mixing Zone.** Effluents released to streams or impounded waters shall be fully and homogeneously dispersed and mixed insofar as practical with the main flow or water body by appropriate methods at the discharge point. Use of a reasonable and limited mixing zone may be permitted on receipt of satisfactory evidence that such a zone is necessary and that it will not create an objectionable or damaging pollution condition.

(11) **Effective Date.** This Paragraph shall become effective on June 30, 1974.
Authority Ga. Laws 1964, p. 416, as amended; Reorganization Act of 1972, Ga. Laws 1972 Sections 32, 1517 and 1534. Effective June 30, 1974. **Administrative History.** Original Rule was filed on June 10, 1974; effective June 30, 1974.

391-3-6-.04 Marine Sanitation Devices.

(1) **Purpose.** The purpose of Paragraph 391-3-6-.04 is to prescribe procedures pertaining to construction, installation and operation of marine sanitation devices, facilities or methods of sewage disposal.

(2) **Definitions.** All terms used in this Paragraph shall be interpreted in accordance with the definitions as set forth in the Act unless otherwise herein defined in this Paragraph or in any other Paragraph of these Rules.

(a) "Boat" means any vessel or watercraft whether moved by oars, paddles, sails, or other power mechanism, inboard or outboard, or any other vessel or structure floating upon the waters of this State whether or not capable of self locomotion, including, but not limited to, cabin cruisers, houseboats, barges and similar floating objects.

(b) "Marine Toilet" means any toilet on or within any boat.

(c) "Other Disposal Unit" means any device on or within any boat, other than marine toilet, which is intended for use in the disposal of human body wastes or sewage.

(d) "Blender" means any mechanical device capable of reducing sewage solids into a finely divided state such that a liquid disinfecting agent may be effectively dispersed throughout the blended sewage.

(e) "Marine Sanitation Devices" mean any equipment for installation on a boat which is designed to receive, retain, treat, or discharge sewage or any process to treat such sewage.

(f) "Sewage," for the purposes of this Paragraph only, means water carried wastes, which are generated by human beings or their activities.

(3) **General Provisions.**

(a) Any marine toilet or other disposal unit located on or within any boat operated on waters of this State shall have securely affixed to the interior discharge toilet or unit a suitable marine sanitation device designed, constructed, and operated in accordance with requirements prescribed herein. All sewage passing into or through the marine toilet or other disposal unit shall discharge solely to the marine sanitation device.

(b) This Paragraph shall not apply to ocean going vessels of 20 tons displacement or more.

(4) **Waste Treatment Devices and Equipment.**

(a) All discharges from marine sanitation devices into or upon the waters of this State shall be in compliance with the Federal standards of performance and regulations for marine sanitation

devices promulgated pursuant to Section 312 of the Federal Act.

(b) Until such time as said Federal standards and regulations are formally promulgated, the following interim requirements will apply:

1. Marine toilets shall be provided with a blender; a device for the addition of a disinfecting agent in such a manner that the disinfection will be thoroughly mixed with and dispersed throughout the blended sewage; and a detention chamber such that the blended sewage and the disinfecting agent will be in contact for not less than ten minutes but not so long as to cause the septic decomposition of the blended sewage. The treatment equipment shall be firmly fastened to the discharge outlet of the marine toilet. The disinfecting agent shall be a five-percent hypochlorite solution or some other solution approved by the Division.

2. *An exception to the requirement that treatment equipment* be fastened to the discharge outlet of a marine toilet shall be granted when such discharge outlet is connected to a holding tank located on the boat; provided that:

(i) such holding tank is constructed so as to prevent the removal of the sewage held therein except by pumping;

(ii) the holding tank is properly vented to the outside air in such fashion as not to foul up the interior of the boat structure;

(iii) chemicals which are added to the holding tank are only those approved by the Division; and

(iv) the contents of holding tanks are disposed of only through onshore facilities approved by the Division.

(c) All onshore discharges from marine sanitation devices or other disposal units shall be accomplished only at or through onshore facilities approved by the Division.

(d) Other wastes, including, but not limited to, garbage, rubbish and litter, shall be deposited onshore in approved receptacles for ultimate disposal in a manner prescribed by the Rules and Regulations of the Solid Waste Management Section of the Division.

(5) **Right of Entry.** Personnel of the Division or other duly authorized agents of the Department shall have access to any boat

at reasonable times for the purpose of determining whether or not there is compliance with the provisions of the Act and the rules of the Division.

(6) **Effective Date.** This Paragraph *shall become effective June* 30, 1974.

Authority Ga. Laws 1964, p. 416, as amended. Effective June 30, 1974. **Administrative History.** Original Rule was filed on June 10, 1974, effective June 30, 1974.

391-3-6-.05 Emergency Actions.

(1) **Purpose.** The purpose of Paragraph 391-3-6-.05 is to provide procedures to handle any emergency which endangers the waters of the State.

(2) **Definitions.** All terms used in this Paragraph shall be interpreted in accordance with the definitions as set forth in the Act unless otherwise defined in this Paragraph or in any other Paragraph of these Rules.

(3) **Notice Concerning Endangering Waters of the State.** Whenever, because of an accident or otherwise, any toxic or taste-and-color producing substance, or any other substance which would endanger downstream users of the waters of the State or would damage property, is discharged into such waters, or is so placed that it *might flow, be washed, or fall into them,* it shall be the duty of the person in charge of such substances at the time to forthwith notify the Division in person or by telephone of the location and nature of the danger, and it shall be such person's further duty to immediately take all reasonable and necessary steps to prevent injury to property and downstream users of said water.

(4) **Emergency Orders.** The Director shall have the authority to issue an emergency order pursuant to Section 20 of the Act, and Section 17(a) of the Executive Reorganization Act of 1972, as amended.

(5) **Effective Date.** This Paragraph shall become effective on June 30, 1974.

Authority Ga. Laws 1964, p. 416, as amended. Effective June 30, 1974. **Administrative History.** Original Rule was filed on June 10, 1974, effective June 30, 1974.

391-3-6-.06 *Waste Treatment and Permit Requirements.*

(1) **Purpose.** The purpose of this Paragraph 391-3-6-.06 is to provide for the degree of waste treatment required and the uniform procedures and practices to be followed relating to the application for or the issuance or revocation of permits for the discharge of

any pollutant into the waters of the State.

(2) **Definitions.** All terms used in this Paragraph shall be interpreted in accordance with the definitions as set forth in the Act unless otherwise defined in this Paragraph or in any other Paragraph of these Rules:

(a) "Effluent Limitation" means any restriction or prohibition established under the Act on quantities, rates, or concentrations, or a combination thereof, of chemical, physical, biological, or other constituents which are discharged from point sources into the waters of the State, including, but not limited to, schedules of compliance.

(b) "NPDES Permit Application" means any application filed by any person with the Director for an NPDES Permit.

(c) "NPDES Permit" means any permit issued by the Division to regulate the discharge of pollutants from any point source into the waters of the State.

(d) "Construction" means any placement, assembly, or installation of facilities or equipment (including contractural obligations to purchase such facilities or equipment) at the premises where such equipment will be used, including preparation work at such premises.

(3) **Permit Requirement.**

(a) Any person discharging or proposing to discharge any pollutant from a point source into the waters of the State, under any of the circumstances described in Section 10(3) of the Act, shall obtain a permit from the Division to make such discharge.

(b) Any person discharging or proposing to discharge any pollutant from a non-point source into the waters of the State, under the circumstances described in Section 10(4) of the Act, shall obtain a permit from the Division to make such discharge.

(c) Any person owning or operating treatment works, from which a discharge into the waters of the State could possibly occur, excluding discharges which could result from Acts of God, shall apply to the Division for a permit.

(4) **Degree of Waste Treatment Required.**

(a) All pollutants shall receive such treatment or corrective action so as to insure compliance with the terms and conditions of the issued permit and with the following, whenever applicable:

1. Effluent limitations established by EPA pursuant to Sections 301 and 302 of the Federal Act.

2. Standards of performance for new sources established by the EPA pursuant to Section 306 of the Federal Act.

3. Effluent limitations and prohibitions and pretreatment standards established by the EPA pursuant to Section 307 of the Federal Act.

4. Notwithstanding the above, more stringent effluent limitations may be required as deemed necessary by the Division to meet (a) any other existing Federal laws or regulations, and (b) to insure compliance with any applicable State water quality standards, effluent limitations, treatment standards, or schedules of compliance.

5. With regard to any non-point source, such effluent limitations as are required to insure compliance with applicable State water quality standards.

(b) The foregoing requirements shall be applied in considering all applications made pursuant to Section 10 of the Act and no such application will be approved unless the waste treatment facilities contemplated thereby will achieve such limitations and standards upon completion thereof or within such reasonable time thereafter as the Division may provide.

(c) Until such time as such standards, limitations, and prohibitions are formally promulgated pursuant to Sections 301, 302, 306, and 307 of the Federal Act, the Division shall apply such standards, limitations, and prohibitions necessary to achieve the purposes of said sections of the Federal Act. With respect to individual point sources, such limitations, standards, or prohibitions shall be based upon an assessment of technology and processes, to-wit:

1. To existing point sources, other than publicly owned treatment works, effluent limitations based on application of the best practicable control technology currently available;

2. To publicly owned treatment works, effluent limitations based upon the application of secondary treatment;

3. To any point source, other than publicly owned treatment works, whose construction commences after the effective date of this Paragraph, effluent limitations which reflect the greatest degree of effluent reduction which the Division determines to be achievable through application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants;

4. To any point source, as appropriate, effluent limitations or prohibitions designed to prohibit the discharge of toxic pollutants in toxic amounts or to require pretreatment of pollutants which interfere with, pass through, or otherwise are incompatible with the operation of publicly owned treatment works; and

5. To any point source, as appropriate, more stringent effluent limitations as are required to insure compliance with applicable State water quality standards.

(5) **Application for Permit.**

(a) Applications for permits under Section 10 of the Act shall be on forms as may be prescribed and furnished from time to time by the Division. Applications shall be accompanied by all pertinent information as the Division may require in order to establish effluent limitations in accordance with subparagraph 391-3-6-.06 (4), including, but not limited to, complete engineering reports, schedule of progress, plans, specifications, maps, measurements, quantitative and qualitative determinations, records, and all related materials.

(b) Engineering reports, plans, specifications, and other material submitted to the Division shall be prepared by a Professional Engineer competent in the field of sewage and industrial waste treatment.

(c) Material submitted shall be complete and accurate.

(d) Any State or NPDES Permit Application form or any other NPDES form submitted to the Division shall be signed as follows:

1. For a corporation, by a principal executive officer of at least the level of vice president, or his duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge described in the State or NPDES Permit Application form originates.

2. For a partnership, by a general partner.

3. For a sole proprietorship, by the proprietor.

4. For a municipal, State, or other public facility, by either a principal executive officer, ranking elected official or other duly authorized employee.

(6) **Receipt and Use of Application and Data.**

(a) Applications for permits will be reviewed together with such other information as may be necessary to ascertain the effect of the discharge of any such pollutant upon the waters into which such pollutant will be discharged.

(b) Copies of the complete NPDES Permit Application received by the Division shall be transmitted to the Regional Administrator for any comment in such manner as the Director and the Regional Administrator shall agree.

(c) The Division shall receive any relevant data collected by the Regional Administrator prior to the Division's participation in the NPDES in such manner as the Director and the Regional Administrator shall agree.

(7) **Notice and Public Participation.**

(a) Tentative Determination and Draft Permits:

1. When the Division is satisfied that the application is complete, a tentative determination will be made to issue or deny the permit. If the tentative determination is to issue the permit, a draft permit will be prepared in accordance with Federal Regulations, 40 C.F.R. Section 124.31, and applicable State laws prior to the issuance of a public notice.

(b) Public Notice:

1. Public notice of every complete permit application will be prepared and circulated in a manner designed to inform interested and potentially interested persons of the proposed discharge and of the proposed determination to issue or deny a permit for the proposed discharge. Procedures for circulation of the public notice shall include the following:

(i) Within the geographical area of the proposed discharge the public notice shall be circulated by at least one of the following: posting in the post office or other public buildings near the premises of the applicant in which the discharge is located; posting at the entrance to the applicant's premises or nearby; or publication in one (1) or more newspapers of general circulation in the area of the applicant.

(ii) Posting of the public notice in the office of the Secretary of State.

(iii) A copy of the public notice shall be mailed to the permit applicant and a copy shall be available at the Division office in Atlanta.

(iv) Mailing of the public notice to any person or group upon written request. The Division shall maintain a mailing list for distribution of public notices and fact sheets. Any person or group may request that their names be added to the mailing list. The request should be in writing to the Division office in Atlanta and shall be renewed in December of each year. Failure to renew the request shall result in the removal of such name from the mailing list.

(v) The Division shall provide a period of not less than thirty (30) days following the date of the public notice in which interested persons may submit their written views on the tentative determination with respect to the NPDES Permit Application. All written comments submitted during the thirty (30) day comment period will be retained by the Division and considered in the final determination with respect to the permit application. The comment period may be extended at the discretion of the Director.

(vi) The contents of the public notice will be in accordance with Federal Regulations, 40 C.F.R. 124.32(c), and applicable State laws.

(vii) The Division will prepare and distribute a fact sheet in accordance with Federal Regulations, 40 C.F.R. 124.33, and applicable State laws. A copy of the fact sheet will be available for public inspection at the Division office in Atlanta. Any person may request in writing a copy of the fact sheet and it will be provided. The Division shall add the name of any person or group upon request to the mailing list to receive copies of fact sheets.

(viii) The Director will notify other appropriate governmental

agencies of each complete permit application and will provide such agencies an opportunity to submit their written views and recommendations in accordance with Federal Regulations, 40 C.F.R. 124.34, and applicable State laws.

(ix) Copies of the proposed permits shall be transmitted to the Regional Administrator for review and comments in such manner as the Director and Regional Administrator shall agree.

(x) The Division shall transmit to the Regional Administrator a copy of every issued NPDES Permit, immediately following issuance, along with any and all terms, conditions, requirements or documents which are part of such permit or which affect the authorization by the permit of the discharge of pollutants.

(c) Public Hearings:

1. The Director shall provide an opportunity for an applicant, any affected state or interstate agency, the Regional Administrator or any other interested agency, person or group of persons to request a public hearing with respect to an NPDES Permit Application. Any such request for a public hearing shall be filed within the 30-day comment period prescribed in sub-paragraph 391-3-6-.06 *(7) (b) (v) and shall indicate the interest of the party filing such* a request, the reasons why a hearing is requested, and those specific portions of the application or other NPDES form or information to be considered at the public hearing. The Director shall hold a hearing if he determines that there is sufficient public interest in holding such a hearing.

2. Any public hearing held pursuant to this subparagraph shall be held in the geographical area of the proposed discharge or other appropriate location at the discretion of the Director.

3. The Director may hold one public hearing on related groups of permit applications.

4. Public notice of any hearing held pursuant to this sub-paragraph shall be provided at least thirty (30) days in advance of the hearing date and shall be circulated in accordance with Federal Regulations, 40 C.F.R. 124.37.

(d) Public Access to Information:

1. A copy of the NPDES Permit Application, public notice, fact

sheet, draft permit and other NPDES forms related thereto, including written public comments thereon and other reports, files and information not involving methods of processes entitled to protection as trade secrets, shall be available for public inspection and copying during normal business hours at the Division office in Atlanta. Effluent data shall not be considered as information entitled to *protection. Public access to such information* shall be in accordance with Federal Regulations, 40 C.F.R. 124.35.

2. Any information submitted in an NPDES Permit Application form, together with reports, records or plans that are considered confidential by the applicant for an NPDES Permit should be clearly labeled "Confidential" and be supported by a statement as to the reasons that such information should be considered confidential. If the Director, with the concurrence of the Regional Administrator, determines that such information is entitled to confidential protection, he shall label and handle same accordingly.

3. When the information being considered for confidential treatment is contained in an NPDES form, the Director shall forward such information to *the Regional Administrator for his concurrence* in any determination of confidentiality.

4. Any information accorded confidential status whether or not contained in an NPDES form shall be made available, upon written request, to the Regional Administrator or his authorized representative who shall maintain the information as confidential.

(8) **Terms and Conditions of Permits.**

(a) Terms and conditions under which the discharge will be permitted will be specified on the permit issued.

(b) No NPDES Permit shall be issued authorizing any of the following discharges:

1. The discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste into navigable waters.

2. Any discharge which the Secretary of the Army acting through the Chief of Engineers finds would substantially impair anchorage and navigation.

3. Any discharge to which the Regional Administrator has objected in writing pursuant to any right to object provided the

Administrator of EPA under Section 402 (d) of the Federal Act. and

4. Any discharge from a point source which is in conflict with a plan or amendment thereto approved pursuant to Section 208 (b) of the Federal Act.

(c) The terms and conditions specified on the permit issued shall be in accordance with Federal Regulations, 40 C.F.R. 124.42 and 124.45 and applicable State laws and regulations promulgated thereunder.

(9) **Publicly Owned Treatment Works.**

(a) If the permit is for a discharge from a publicly owned treatment works, assurance shall be obtained from the applicant prior to issuance of any permit that notice shall be provided to the Director of the following:

1. Any new introduction of pollutants into such treatment works from a source which would be a new source as defined in Section 306 of the Federal Act if such source were discharging pollutants;

2. Except as to such categories and classes of point sources or discharges specified by the Director, any new introduction of pollutants into such treatment works from a source which would be subject to Section 301 of the Federal Act if such source were discharging pollutants; and

3. Any substantial change in volume or character of pollutants being introduced into such treatment works by a source introducing pollutants into such works at the time of issuance of the permit.

(b) If the permit is for a discharge from a publicly owned treatment works, the permittee shall require any industrial user of such *treatment works to comply with the requirements of Sections 204* (b), 307, and 308 of the Federal Act. As a means of insuring compliance with Section 307 of the Federal Act, the permittee shall require each industrial user subject to the requirements of said Section 307 to forward to the Director periodic notice of progress (over intervals not to exceed 9 months) toward full compliance with Section 307 requirements.

(10) **Schedules of Compliance.**

(a) Any person who obtains an NPDES Permit or other dis-

charge permit pursuant to the Act but who is not in compliance with applicable effluent standards and limitations or other requirements contained in such permit at the time same is issued, shall be required to achieve compliance with such standards and limitations or other requirements in accordance with a schedule of compliance as set forth in such permit, or in the absence of a schedule of compliance, by the date set forth in such permit which the Director has determined to be the shortest, reasonable period of time necessary to achieve such compliance.

(b) In any case where the period of time for compliance specified in sub-paragraph 391-3-6-.06 (10) (a) of these Rules exceeds 9 months, a schedule of compliance shall be specified in the permit which will set forth interim requirements and the dates for their achievement. In no event shall more than 9 months elapse between interim dates, and, to the extent practicable, shall fall on the last day of the months of March, June, September and December.

(c) Within fourteen (14) days after an interim date of compliance or the final date of compliance specified in such permit, the permittee shall provide the Director with written notice of his compliance or noncompliance with the requirements or conditions specified to be completed by such date. Failure to submit the written notice is just cause for the Division to pursue enforcement action pursuant to the Act.

(d) On the last working day of the months of February, May, August, and November, the Director shall prepare and submit to the Regional Administrator a list of all dischargers holding NPDES Permits which, as of the thirty (30) days prior to the date of the list, have submitted to the Director a report showing noncompliance with the requirements set forth in the permit and those which have not filed a timely report. The noncompliance list shall be available to the public at appropriate Division offices for inspection and copying, and shall contain the following information:

1. The name and address of each non-complying permittee;

2. A concise description of the nature of noncompliance;

3. A description of proposed actions to be taken by the Division or the permittee to correct the noncompliance; and

4. Any other information deemed necessary by the Division to explain or mitigate an instance of noncompliance.

(e) A discharger who fails or refuses to comply with an interim or final date of compliance specified in a permit may be deemed by the Director to be in violation of the permit and may be subject to enforcement action pursuant to the Act.

(11) **Monitoring, Recording and Reporting Requirements.** Any discharge authorized by a permit issued pursuant to the Act may be subject to such monitoring, recording and reporting requirements as may be reasonably required by the Director including the installation, use and maintenance of monitoring equipment or methods; specific requirements for recording of monitoring activities and results; and periodic reporting of monitoring results. The monitoring, recording and reporting requirements shall be specified in a permit when issued, provided, however, the Director may modify or require additional monitoring, recording and reporting by written notification to the permittee.

(a) The monitoring requirement of any discharge authorized by any such permit shall be consistent with Federal Regulations, 40 C.F.R. 124.61 and applicable State laws.

(b) Any permit which requires monitoring of the authorized discharge shall comply with the recording requirements specified by Federal Regulations, 40 C.F.R. 124.62 and applicable State laws. The permittee shall be required to retain any records of monitoring activities and results for a minimum of three (3) years, unless otherwise required or extended by the Director upon written notification.

(c) Any holder of a permit which requires monitoring of the authorized discharge shall report periodically to the Division the results of all required monitoring activities on appropriate forms supplied by the Division. The Director shall notify the permittee of the frequency of reporting but in no case shall the reporting frequency be less than once per year.

(12) **Modification, Suspension and Revocation of Permits.**

(a) The Director may revise or modify the schedule of compliance set forth in an issued permit if the permittee requests such modification or revision in writing and such modification or revision will not cause an interim date in the compliance schedule to be extended more than one hundred twenty (120) days or affect the final date in the compliance schedule. If the permittee requests in writing a modification or revision of a schedule of compliance set forth in

an issued permit which, if granted, would cause an interim date in the compliance schedule to be extended more than one hundred twenty (120) days or affect the final date in the compliance schedule, the Director may revise or modify such schedule of compliance if within thirty (30) days following receipt of notice of such request from the Director, the Regional Administrator does not object to same in writing and file such written objection with the Director. The Director may grant requests in accordance with this subparagraph if he determines after a documented showing by the permittee that good and valid cause (including Acts of God, strikes, floods, material shortages or other events over which the permittee has little or no control) exists for such revision.

(b) The Director may modify, suspend or revoke an issued permit in whole or in part during its term for cause, *including, but* not limited to, failure or refusal of the permittee to carry out the requirements listed in Federal Regulations, 40 C.F.R. 124.45(c), the causes listed in *Federal Regulations, 40 C.F.R. 124.45(b)*, or the causes listed in the Act or regulations promulgated pursuant thereto, if within thirty (30) days following receipt of notice of such proposed *modification, suspension* or revocation from the Director, the Regional Administrator does not object to same in writing and file such written objection with the Director. Prior to any such modification, suspension or revocation of an issued permit by the Director (other than modification or revision of a compliance schedule pursuant to subparagraph (a) above or modification of monitoring, recording or reporting requirements), the Director will provide public notice in accordance with the procedures set forth in subparagraph 391-3-6-.06(7) (b) and an opportunity for public hearing in accordance with the procedures set forth in subparagraph 391-3-6-.06(7) (c).

(13) ***Non-governmentally* Owned Sewerage Systems.** In cases involving non-governmentally owned sewerage systems, a trust indenture or other legal contract or agreement, approved by the Division, assuring continuity of operation of the system, shall be filed with the application for a permit. This provision shall not be applicable to systems discharging only industrial waste.

(14) **Control of Disposal of Pollutants into Wells.** If the permit proposes to discharge to a well or subsurface water, the Director shall specify additional terms and conditions which shall (a) prohibit the proposed disposal, or (b) control the proposed disposal in order to prevent pollution of ground and surface water resources and to protect the public health and welfare. Any permit issued for

the disposal of pollutants into wells shall comply with Federal Regulations, 40 C.F.R. 124.80, and applicable State laws.

(15) **Duration of Permits.** Any permit issued under Section 10(3) and (4) of the Act shall have a fixed term not to exceed *five (5) years. Upon expiration of* such *permit*, a new permit may be issued by the Director in accordance with Section 10(6) of the Act and Federal Regulations, 40 C.F.R. 124.52, provided that an *application for* such new permit is filed with the Director at least 180 days prior to the expiration date of the existing permit. The issuance of such new permit shall likewise have a fixed term not to exceed five (5) years.

(16) **Enforcement.** Any person who violates any provision of the Act, any rule promulgated and adopted pursuant thereto, or any term, condition, schedule of compliance or other requirement contained in a permit issued pursuant to the Act shall be subject to enforcement proceedings pursuant to the Act.

(17) **Effective Date.** This Paragraph shall become effective on June 30, 1974.

Authority Ga. Laws 1964, p. 416, as *amended*, Ga. Laws 1972, p. 1015, as *amended*. Effective June 30, 1974. **Administrative History.** Original Rule was filed on June 10, 1974, effective June 30, 1974.

NEXT PAGE IS 1001

CLASSIFICATIONS FOR THE WATERS
OF THE STATE OF GEORGIA

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

MAY 1975

Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION
270 WASHINGTON STREET, S W
ATLANTA, GEORGIA 30334

JOE D. TANNER
Commissioner

J. LEONARD LEDBETTER
Division Director

INTRODUCTION

This document lists the classifications for the waters of the State of Georgia in force as of May 1975. The classifications are in accord with the Georgia Water Quality Control Act and the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500).

The initial stream classifications were made in July 1967 and applied to interstate waters only. In June 1972, the State classified approximately 1,420 miles of major intrastate streams. In March 1974, classifications for the remaining unclassified streams were adopted. Additionally, more than 3,000 miles of north Georgia streams have also been designated as trout waters by the Game and Fish Division of the Department of Natural Resources. An amendment to the Wild and Scenic Rivers Act in May 1974 has also designated 8.1 miles of Georgia streams as "Wild and Scenic."

Water quality criteria applicable to the various stream classifications are published in Chapter 391-3-6 of the document entitled Rules and Regulations for Water Quality Control, Georgia Department of Natural Resources, Environmental Protection Division, which is based on the State of Georgia Water Quality Control Act as Amended Through 1974. The criteria relating to the "Wild and Scenic" classification can be found in Public Law 93-279.

Ga. 1776 1976

Department of Natural Resources

ENVIRONMENTAL PROTECTION DIVISION

Stream Categories

Streams and stream reaches not listed below for specific classifications will fit into the following categorical classifications:

A. Streams and stream reaches which are not shown on the Georgia Department of Transportation's official county maps are not classified unless they receive a wastewater discharge. In that case, they are classified as fishing.

B. Streams and stream reaches which are shown as naturally intermittent, ephemeral or a combination thereof on the Georgia Department of Transportation's official county maps or which can be documented as being intermittent by records of the United States Geological Survey are not classified unless they receive a wastewater discharge. In that case, they are classified as fishing.

C. Stream channels, drainage ditches and canals which are naturally intermittent, ephemeral or a combination thereof are not classified.

D. Streams and stream reaches not specifically classified below and not categorically classified above (A, B, or C) are classified as fishing.

Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION

CLASSIFICATIONS FOR THE WATERS
OF THE STATE OF GEORGIA

MAY, 1975

SAVANNAH RIVER BASIN		CLASSIFICATION
Savannah River	Georgia-North Carolina State Line to Clark Hill Dam (Mile 238)	Recreation
Savannah River	Clark Hill Dam (Mile 238) to Augusta, 13th Street Bridge	Drinking Water
Savannah River	Augusta, 13th Street Bridge to U.S. Hwy. 301 Bridge (Mile 129)	Fishing
Savannah River	U.S. Hwy. 301 Bridge (Mile 129) to U.S. Hwy. 17 Bridge (Mile 22)	Drinking Water
Savannah River	U.S. Hwy. 17 Bridge (Mile 22) to Field's Cut (Mile 5)	Industrial Navigational
Savannah River	Field's Cut (Mile 5) to Fort Pulaski (Mile 0)	Fishing
Savannah River	Fort Pulaski (Mile 0) to Open Sea and all littoral waters of Tybee Island	Recreation
Butler Creek (and its tributaries)	Headwaters in Augusta to confluence with Savannah River	Urban
Cason's Dead River (and its tributaries)	Headwaters in Augusta to confluence with Savannah River	Urban
Chattooga River	Georgia-North Carolina State Line to Tugaloo Reservoir (0.8 mi)	Wild and Scenic
West Fork Chattooga River	Confluence of Overflow Creek and Clear Creek to confluence with Chattooga River (7.3 mi)	Wild and Scenic

OGEECHEE RIVER BASIN		CLASSIFICATION
Ogeechee River	Headwaters to U.S. Hwy 80 Bridge	Fishing
Ogeechee River	U.S. Hwy 80 Bridge to U.S. Hwy 17 Bridge	Fishing
Ogeechee River	U.S. Hwy 17 Bridge to Open Sea and littoral waters of Skidaway, Ossabaw, Sapelo and St. Catherines Islands	Recreation
Little Ogeechee River	Headwaters to U.S. Hwy 80 Bridge	Fishing
Little Ogeechee River	U.S. Hwy 80 Bridge to South End of White Bluff Road near Carmelite Monastery	Fishing
Little Ogeechee River	South End of White Bluff Road near Carmelite Monastery to Open Sea and littoral waters of skidaway and Ossabaw Islands	Recreation

OCONEE RIVER BASIN		CLASSIFICATION
Middle Oconee River	Headwaters to Georgia Highway 82	Fishing
Middle Oconee River	Georgia Highway 82 to U.S. Hwy 78	Drinking Water
Middle Oconee River	U.S. Hwy 78 to confluence with North Oconee River	Fishing
North Oconee River	Headwaters to State Route 2434	Fishing
North Oconee River	State Route 2434 to Athens Water Intake.	Drinking Water
North Oconee River	Athens Water Intake to confluence With Middle Oconee River	Fishing
Oconee River	From confluence of North and Middle Oconee Rivers to Georgia Hwy 16	Fishing
Oconee River	Georgia Highway 16 to Sinclair Dam	Recreation
Oconee River	Sinclair Dam to Georgia Highway 22	Drinking Water
Oconee River	Georgia Highway 22 to Georgia Hwy 57	Fishing
Oconee River	Georgia Highway 57 to U.S. Hwy 80	Drinking Water
Oconee River	U.S. Hwy 80 to confluence with Ocmulgee River	Fishing

Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION

OCONEE RIVER BASIN (con't)		CLASSIFICATION
Trail Creek	Headwaters in Athens to confluence with N. Oconee River	Urban

UPPER OCMULGEE RIVER BASIN		CLASSIFICATION
South River	Headwaters to Georgia Highway 81	Urban
South River	Georgia Highway 81 to Georgia Highway 36	Fishing
Yellow River	Headwaters to Georgia Highway 124	Fishing
Yellow River	Georgia Highway 124 to Porterdale Water Intake	Drinking Water
Yellow River	Porterdale Water Intake to Georgia Highway 36	Fishing
Alcovy River	Headwaters to Georgia Highway 138	Fishing
Alcovy River	Georgia Highway 138 to Covington Water Intake	Drinking Water
Alcovy River	Covington Water Intake to Newton Factory Road Bridge	Fishing
Jackson Lake	From South River at Georgia Hwy 36 From Yellow River at Georgia Hwy 36 From Alcovy River at Newton Factory Road Bridge to Lloyd Shoals Dam	Recreation
Intrenchment Creek	Headwaters in Atlanta to confluence With South River	Urban
Shoal Creek	Headwaters in Dekalb County to confluence with South River	Urban
Conley Creek	Headwaters near Atlanta Army Depot to confluence with South River	Urban
Doolittle Creek	Headwaters in Dekalb County to confluence with South River	Urban
Snapfinger Creek	Headwaters in Dekalb County to confluence with South River	Urban

LOWER OCMULGEE RIVER BASIN		CLASSIFICATION
Ocmulgee River	Lloyd Shoals Dam to Georgia Highway 18	Fishing
Ocmulgee River	Georgia Highway 18 to Macon Water Intake	Drinking Water
Ocmulgee River	Macon Water Intake to Georgia Highway 96	Industrial
Ocmulgee River	Georgia Highway 96 to confluence with Oconee River	Fishing
Towaliga River	Headwaters to Georgia Highway 36	Drinking Water
Towaliqa River	Georgia Highway 36 to High Falls Dam	Recreation
Walnut Creek	Macon City Limits to confluence with Ocmulgee River	Urban
Cabin Creek	Headwaters in Griffin to Parham Road	Urban
Tobesofkee Creek	Lake Tobesofkee	Recreation
Tobesofkee Creek	Tobesofkee Dam to confluence with Ocmulgee River	Urban

ALTAMAHA RIVER BASIN		CLASSIFICATION
Altamaha River	Confluence of Oconee and Ocmulgee Rivers to U.S. Hwy 301	Fishing
Altamaha River	U.S. Hwy 301 to Altamaha Sound	Fishing
	All littoral waters on the ocean side of St. Simons, Sea, and Sapelo Islands.	Recreation
Ohoopee River	Headwaters to confluence with Altamaha River	Fishing
Mackay River	Confluence with Altamaha River to St. Simons Sound	Fishing
Back River	Northern confluence with Mackay River to Southern confluence with Mackay River	Fishing
Frederica River	Northern confluence with Mackay River to Southern confluence with Mackay River	Fishing

SATILLA RIVER BASIN		**CLASSIFICATION**
Satilla River	Headwaters to Seaboard Coast Line Railroad	Fishing
Satilla River	Seaboard Coast Line Railroad to St. Andrews Sound	Fishing
Little Satilla River	Seaboard Coast Line Railroad to St. Andrews Sound	Fishing
East River	South End to West End	Navigation
Turtle and Brunswick Rivers	Headwaters to St. Simons Sound	Fishing
	All littoral waters on ocean side of Cumberland and Jekyll Islands	Recreation
Kettle Creek	Headwaters at Waycross to confluence with Satilla River	Urban
City Creek	Headwaters at Waycross to confluence with Satilla River	Urban
Twenty-Mile Creek	Georgia Highway 353 near Douglas to confluence with Seventeen-Mile Creek	Urban
ST. MARYS RIVER BASIN		**CLASSIFICATION**
St. Marys River	Headwaters to Cumberland Sound	Fishing
North River	Headwaters to confluence with St. Marys River	Industrial
	All littoral waters on ocean side of Cumberland Island	Recreation
SUWANNEE RIVER BASIN		**CLASSIFICATION**
Suwannee River	Headwaters to Georgia-Florida State line.	Fishing
Alapaha River	Headwaters to Georgia-Florida State line.	Fishing
Withlacoochee River (Withlacoochee Creek)	Headwaters to Georgia-Florida State line	Fishing

Department of Natural Resources

ENVIRONMENTAL PROTECTION DIVISION

OCHLOCKNEE RIVER BASIN		CLASSIFICATION
Ochlocknee River	Headwaters to Georgia-Florida State line	Fishing
Aucilla River (including Aucilla Creek)	Headwaters to Georgia-Florida State line	Fishing
Oquina Creek (and its tributaries)	Headwaters in Thomasville to confluence with Ochlocknee River	Urban
Parkers Mill Creek	Headwaters in Cairo to confluence with Tired Creek	Urban

FLINT RIVER BASIN		CLASSIFICATION
Flint River	Headwaters to Georgia Highway 54	Industrial
Flint River	Georgia Highway 54 to S1061, Woolsey Road	Fishing
Flint River	S1061, Woolsey Road,to Georgia Highway 16	Drinking Water
Flint River	Georgia Highway 16 to Georgia Highway 27	Fishing
Flint River	Georgia Highway 27 to Georgia Power Company Dam at Lake Worth, Albany	Recreation
Flint River	Georgia Power Company Dam at Lake Worth, Albany to Bainbridge, U.S. Hwy 84 Bridge	Fishing
Flint River	Bainbridge, U.S. Hwy 84 Bridge to Jim Woodruff Dam, Lake Seminole	Recreation
Sullivan Creek	Headwaters in College Park to Confluence with Flint River	Urban
Mud Creek	Headwaters in Hapeville to confluence with Flint River	Urban

CHATTAHOOCHEE RIVER BASIN		CLASSIFICATION
Chattahoochee River	Headwaters to Buford Dam	Recreation
Chattahoochee River	Buford Dam to Atlanta (Peachtree Creek)	Drinking Water & Recreation

Chattahoochee River	Atlanta (Peachtree Creek) to Cedar Creek	Fishing*

*Condition: Specific Criteria apply at all times when the River flow measured at a point immediately upstream from Peachtree Creek equals or exceeds 750 cfs (Atlanta gage flow minus Atlanta water supply withdrawal) unless violations occur due to uncontrolled urban storm run off and/or combined sewer overflows.

Chattahoochee River	Cedar Creek to Franklin, Georgia (U.S. Hwy 27)	Fishing
Chattahoochee River	U.S. Hwy 27 Bridge at Franklin to West Point Dam	Recreation
Chattahoochee River	West Point Dam to West Point Mfg. Company Water Intake	Drinking Water
Chattahoochee River	West Point Mfg. Company Water Intake to Osanippa Creek	Fishing
Chattahoochee River	Osanippa Creek to Columbus, Georgia (14th Street Bridge)	Recreation Drinking Water
Chattahoochee River	Columbus, Georgia (14th Street Bridge) to Cowikee Creek	Fishing
Chattahoochee River	Cowikee Creek to Great Southern Division of Great Northern Paper Company	Recreation
Chattahoochee River	Great Southern Division of Great Northern Paper Company to Georgia Highway 91 (Neal's Landing)	Fishing
Chattahoochee River	Georgia Highway 91 (Neal's Landing) to Jim Woodruff Dam	Recreation
Flat Creek	Headwaters in Gainesville to Chattahoochee River	Urban
Sope Creek	Headwaters in Marietta to Chattahoochee River	Urban
Rottenwood Creek	Headwaters in Marietta to Chattahoochee River	Urban
Nickajack Creek	Headwaters in Marietta to Chattahoochee River	Urban
Peachtree Creek (and its tributaries)	Headwaters to Chattahoochee River	Urban

Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION

Proctor Creek	Headwaters in Atlanta to Chattahoochee River	Urban
Sandy Creek	Headwaters in Atlanta to Chattahoochee River	Urban
Utoy Creek	Headwaters in East Point to Chattahoochee River	Urban
Olley Creek	Headwaters in Marietta to Sweetwater Creek	Urban

TALLAPOOSA RIVER BASIN		CLASSIFICATION
Tallapoosa River	Headwaters to Georgia Highway 100	Drinking Water
Tallapoosa River	Georgia Highway 100 to Georgia-Alabama State Line	Fishing
Little Tallapoosa River	Headwaters to SCS Dam No. 36 (Carrollton Raw Water Intake)	Drinking Water
Little Tallapoosa River	SCS Dam No. 36 (Carrollton Raw Water Intake) to Georgia-Alabama State Line.	Fishing

COOSA RIVER BASIN		CLASSIFICATION
Conasauga River	Georgia Highway 2 to Dalton Water Intake	Drinking Water
Conasauga River	Dalton Water Intake to confluence with Coosawattee River	Fishing
Ellijay River	Headwaters to Ellijay Water Intake	Drinking Water
Ellijay River	Ellijay Water Intake to confluence with Cartecay River	Fishing
Cartecay River	Headwaters to Ellijay Water Intake	Drinking Water
Cartecay River	Ellijay Water Intake to confluence with Ellijay River	Fishing
Coosawattee River	From confluence of Ellijay and Cartecay Rivers to confluence with Mountaintown Creek	Fishing
Coosawattee River	Confluence of Mountaintown Creek to Carters Dam	Recreation
Coosawattee River	Carters Dam to confluence with Conasauga River	Fishing

Department of Natural Resources

ENVIRONMENTAL PROTECTION DIVISION

Oostanaula River	Confluence of Conasauga and Coosawattee Rivers to Calhoun Water Intake	Drinking Water
Oostanaula River	Calhoun Water Intake to confluence with Armuchee Creek	Fishing
Oostanaula River	Confluence with Armuchee Creek to Rome Water Intake	Drinking Water
Oostanaula River	Rome Water Intake to confluence with Etowah River	Fishing
Etowah River	Headwaters to State Route 2551	Fishing
Etowah River	State Route 2551 to Canton Water Intake	Drinking Water
Etowah River	Canton Water Intake to Georgia Highway 20	Fishing
Etowah River	Georgia Highway 20 to Allatoona Dam	Recreation Drinking Water
Etowah River	Allatoona Dam to Cartersville Water Intake	Drinking Water
Etowah River	Cartersville Water Intake to confluence with Oostanaula River	Fishing
Coosa River	Rome - confluence of Oostanaula and Etowah Rivers to Georgia-Alabama State Line	Fishing
Coosa River	Alabama State Line	Recreation
Chattooga River	Headwaters to Georgia-Alabama State Line	Fishing
Mill Creek	Headwaters to Dalton Water Supply	Drinking Water
Mill Creek	Dalton Water Supply to confluence with Coahulla Creek	Urban
Drowning Bear Creek	From confluence with Tar Creek in Dalton to Conasauga River	Urban
Silver Creek	Headwaters to confluence with Etowah River near Rome	Urban
City Creek	Headwaters to confluence with Chattooga Creek at LaFayette	Urban

Department of Natural Resources

ENVIRONMENTAL PROTECTION DIVISION

TENNESSEE RIVER BASIN		CLASSIFICATION
Little Tennessee River	Headwaters to Georgia-North Carolina State Line	Fishing
Hiawassee River (including Lake Chatuge)	Headwaters to Georgia-North Carolina State Line	Recreation
Nottely River	Headwaters to Georgia-North Carolina State Line	Recreation
Toccoa River (including Lake Blue Ridge)	Headwaters to Georgia-Tennessee State Line	Recreation
South Chickamauga Creek	Headwaters to Georgia-Tennessee State Line	Fishing
West Chickamauga Creek	Headwaters to Georgia-Tennessee State Line	Fishing
Spring Creek	Headwaters to Georgia-Tennessee State Line	Fishing
Dry Creek	Headwaters to Georgia-Tennessee State Line	Fishing
Chattanooga Creek	Headwaters to Georgia-Tennessee State Line	Fishing
Lookout Creek	Headwaters to Georgia-Tennessee State Line	Fishing

APPENDIX H

CHATTAHOOCHEE RIVER COMPARATIVE MODEL STUDY USING DOSAG II AND WQRRS

APPENDIX H

CHATTAHOOCHEE RIVER COMPARATIVE MODEL STUDY USING DOSAG II AND WQRRS

by

Ken Iceman[1]

I. INTRODUCTION

An integral part of the Chattahoochee River Study conducted by HEC for the Savannah District and WES was the comparison of the WQRRS water quality model (1) and the present version of DOSAG II (2). The DOSAG II model operates in a steady-state hydraulic mode with a temporal accounting of the BOD_5 and dissolved oxygen (DO) stream concentrations subject to their interdependencies, external loadings, and reaeration.

In an effort to operate the WQRRS model in the same hydraulic mode as DOSAG II, the program was executed for several days with constant tributary flows until a steady state condition was observed for the temperature, BOD_5, and DO. A simulation period of six to eight days was sufficient to attain this condition in all reaches. When these parameters remained constant for two or more days, the results were compared and plotted on figure H-1 along with the DOSAG II concentration profiles over the reach length.

Through this demonstration problem of the WQRRS water quality model, the ability to produce similar profiles to those of the DOSAG II model for BOD_5 and dissolved oxygen is shown. Where deviations do exist, an effort is made to point out some technical model differences which can explain these variances and should be judged accordingly.

It is suggested, by way of these comparisons, that the WQRRS water quality model has the ability to predict the BOD_5 and dissolved oxygen with similar results to DOSAG II, as well as having the flexibility of modeling additional water quality parameters. With time dependent flows,

[1]Ken Iceman, Research Hydraulic Engineer, The Hydrologic Engineering Center.

a dynamic simulation state can be achieved with the WQRRS model for all constituents in addition to the steady-state method of operation, as noted previously.

II. IMPORTANT TECHNICAL MODEL DIFFERENCES

Geometry

The WQRRS computer model requires as input a distribution of the cross-section characteristics of each subreach along with the associated hydraulic radius, Mannings n factor and elevation. These data, in conjunction with a Muskingum routing procedure, are used in the determination of flow through the river system. Due to this method of computing flows and velocities from channel geometry and characteristics, the velocities are generally different than those computed from the empirical exponential relation used by DOSAG II.

These variances in velocity can significantly alter the reaeration contribution to the DO concentration through the dependence of the K_2 reaeration coefficient on velocity. This is elaborated upon later in the discussion about reaeration.

Heat Budget and Temperature

The WQRRS model uses a complete heat budget analysis incorporating such variables as weather conditions, short and long wave radiation, cloudiness, sun angle, latitude, longitude, and atmospheric turbidity. These parameters may be input as variable or constant throughout the simulation period, depending on desired accuracy and availability of adequate information. The DOSAG II model accounts for temperature variation through measured basin data during the study period. Tributary inputs and fluctuations over the day and month are incorporated in the data reduction methods used to obtain the stretch basin parameters. Once these temperatures and quality parameters are reduced for the DOSAG II model, they remain constant throughout each stretch, which may contain one or more tributary inputs.

An effort was made in preparing the input data to the WQRRS model to delineate each inflow temperature for every stream reach. This was accomplished either through communications with data collection agencies in Georgia or from the DOSAG II input descriptions sent to HEC by the EPD (Environmental Protection Division - Georgia, State Department of Natural Resources).

As a result of the discretization of load quality parameters and the incorporation of a complete heat budget, the temperatures computed in the study area take on different and slightly higher values than those indicated in the DOSAG II results. The slight variations in temperature seldom exceed two or three degrees centigrade and, therefore, may account for only minor changes in quality. Never the less, the contribution to the water quality through temperature changes as a function of time should be acknowledged, and will affect the exact comparability of model results.

Reaeration

The method of determining the reaeration coefficient K_2 in DOSAG II for this portion of the Chattahoochee River is through the expression:

$$K_2 = c\left(\frac{\Delta h}{t_f}\right)$$

where both c and Δh are input values by reach segments and are described as the constant of proportionality and change in water surface elevation respectively. The travel time, t_f, and reaeration coefficient, K_2, within each reach segment are computed internally by DOSAG II.

In the WQRRS development, the method of calculating K_2 is left up to the individual user. Although a complete sensitivity analysis on the K_2 calculation was not performed, it was concluded by experimentation with the various methods on Reach 1 that the O'Conner and Dobbins expression for K_2 would result in DO concentration profiles most similar to the DOSAG II method. Exact values of K_2 were not used from DOSAG II since the computation of velocity was different between the two models.

The different methods used for the calculation of K_2 in DOSAG II and WQRRS models lead to some descrepancies in concentration profiles. If the values of velocities throughout the study area are investigated, it is seen that the concentration profiles of DO deviate in places where the velocities have the greatest difference. This is consistent with the alternative methods of computing K_2 in each model.

III. COMPARISON OF RESULTS

The concentration profiles of both dissolved oxygen and BOD_5 are seen in figure J-1 to compare very well in response to tributary loading conditions over the study area.

The greatest variance of dissolved oxygen occurs between river miles 375 and 344 where the velocities computed by WQRRS were generally 20 to 100 percent greater than those computed in DOSAG II. This velocity variation, along with the method of computing K_2 in the WQRRS model, would definitely imply higher values of DO.

A run of Reach 6 (river miles 366 to 340) was made using the exact values of K_2, as computed through the DOSAG II equation $K_2 = c(\frac{\Delta h}{t_f})$. Although these values had to be interpolated at a few points because of our differing river mile delineations, the main concept of using the DOSAG II K_2 values was incorporated. More importantly, the direct dependence on velocity was eliminated. The results showed the DO concentrations in Reach 6 nearly 1.5 mg/l less than when K_2 was computed by the O'Conner and Dobbins methods. This demonstrated that the differing velocities between the two models was a significant contributor to the descrepancies noted in the DO profiles given by the WQRRS method of calculating K_2.

The BOD concentration profiles show very similar responses throughout the study area. Where the R.M. Clayton sewage treatment plant discharges to the Chattahoochee, the BOD concentrations vary the most. This is due, in part, to the method of decay used in the WQRRS model where both

nitrogeneous and carbonaceous BOD are decayed simultaneously and at the same rate when use is not being made of the nitrogen cycle portions of the WQRRS logic. In DOSAG II, the decay can be split between carbonaceous and nitrogenous BOD, as well as at different rates. Since only carbonaceous BOD is decayed in DOSAG II until downstream of R.M. Clayton, the DOSAG II model would be expected to experience a more amplified loading than the WQRRS model. Downstream of the R.M. Clayton plant where both nitrogenous and carbonaceous BOD_5 are decayed in DOSAG II, we see a much greater similarity of profiles. In upstream reaches the agreement is quite good, but there is very little BOD available.

It is from this figure, H-1, which shows a complete concentration profile comparison plot for both dissolved oxygen and BOD_5 (C + N), and the previously mentioned model differences, that the resulting conclusions have been derived.

IV. CONCLUSIONS

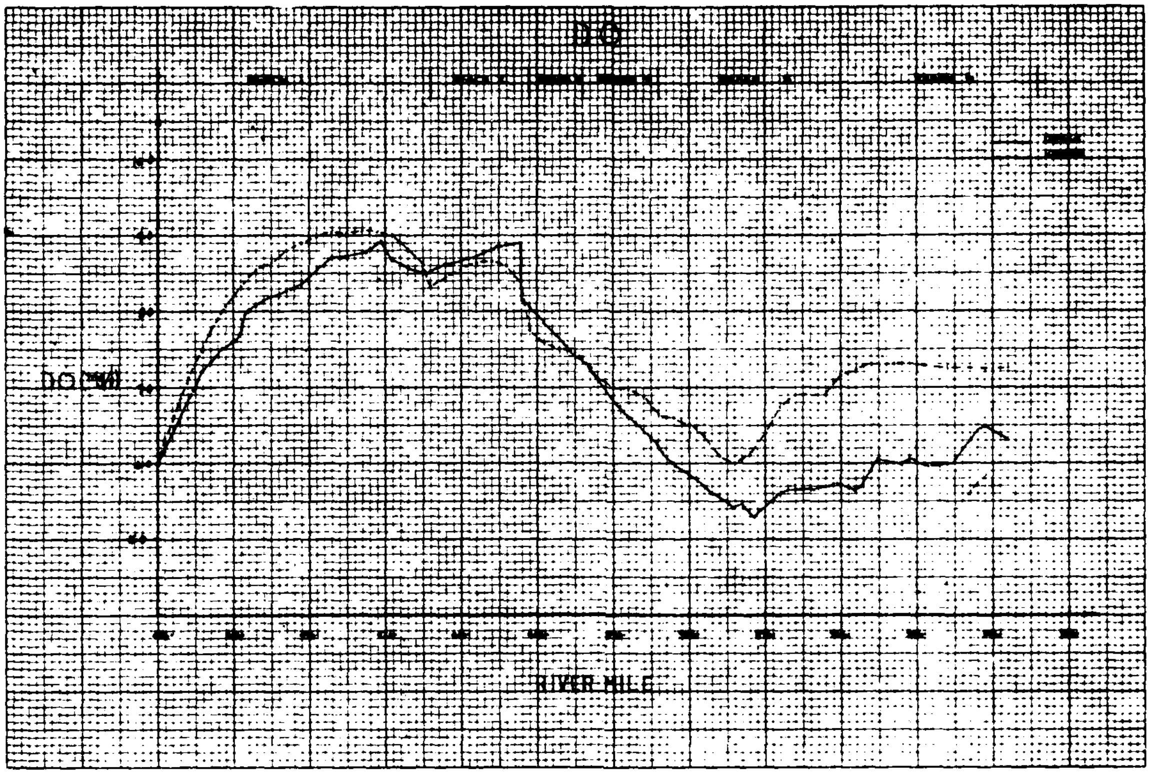
The results of the WQRRS model have been demonstrated to compare adequately with the DOSAG II program results. The additional capabilities of dynamic hydraulic computation and complete heat budget analysis give a greater degree of flexibility and completeness in water quality studies of rivers. Any discrepancies present in concentration profiles throughout the study area can be adequately explained by references to the technical model differences. It is with this knowledge and understanding, determined in the Chattahoochee River study, that HEC recommends the use of the WQRRS water quality model for future studies of river systems which require dynamic analysis.

References:

1) "Flow Routing and Water Quality Simulation for River-Reservoir Systems," Resource Management Associates, Lafayette, California, 1975.

2) "DOSAG II Computer Model," Georgia State Department of Natural Resources, Environmental Protection Division, Atlanta, Georgia.

Concentration Profiles on Chattahoochee River



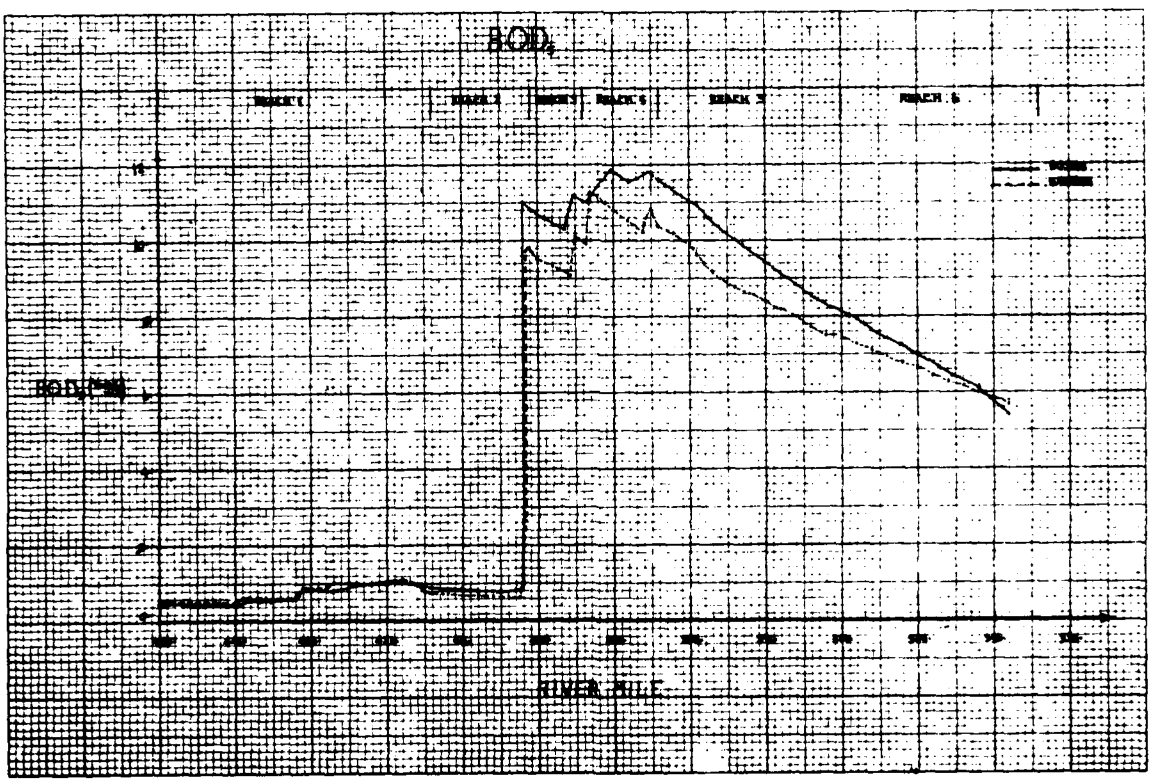


Figure H-1

APPENDIX I

METRIC-ENGLISH UNIT

CONVERSION TABLES

Table of Contents

TEMPERATURE CONVERSION

Absolute Temperatures

°Kelvin = °C + 273
°Rankine = °F + 460

Conversion Factors

$$°F - 32 = \frac{°C \times 9}{5}$$

$$°C = \frac{(°F - 32) \times 5}{9}$$

Interpolation Figures

°F		°C	°F		°C
1.8	1	0.6	10.8	6	3.3
3.6	2	1.1	12.6	7	3.9
5.4	3	1.7	14.4	8	4.4
7.2	4	2.2	16.2	9	5.0
9.0	5	2.8	18.0	10	5.6

The bold figures are the temperature readings in °C or °F, which can be converted to °F or °C, respectively

14°F	**-10**	-23.3°C	104°F	**40**	4.44°C	194°F	**90**	32.2°C	770°F	**410**	210°C
15.8	**- 9**	-22.8	106	**41**	5.00	196	**91**	32.8	788	**420**	216
17.6	**- 8**	-22.2	108	**42**	5.56	198	**92**	33.3	806	**430**	221
19.4	**- 7**	-21.7	109	**43**	6.11	199	**93**	33.9	824	**440**	227
21.2	**- 6**	-21.1	111	**44**	6.67	201	**94**	34.4	842	**450**	232
23.0	**- 5**	-20.6	113	**45**	7.22	203	**95**	35.0	860	**460**	238
24.8	**- 4**	-20	115	**46**	7.78	205	**96**	35.6	878	**470**	243
26.6	**- 3**	-19.4	117	**47**	8.33	207	**97**	36.1	896	**480**	249
28.4	**- 2**	-18.9	118	**48**	8.89	208	**98**	36.7	914	**490**	254
30.2	**- 1**	-18.3	120	**49**	9.44	210	**99**	37.2	932	**500**	260
32.0	**0**	-17.8	122	**50**	10.0	212	**100**	37.8	950	**510**	266
33.8	**1**	-17.2	124	**51**	10.6	214	**101**	38.3	968	**520**	271
35.6	**2**	-16.7	126	**52**	11.1	216	**102**	38.9	986	**530**	277
37.4	**3**	-16.1	127	**53**	11.7	217	**103**	39.4	1004	**540**	282
39.2	**4**	-15.6	129	**54**	12.2	219	**104**	40.0	1022	**550**	288
41.0	**5**	-15.0	131	**55**	12.8	221	**105**	40.6	1040	**560**	293
42.8	**6**	-14.4	133	**56**	13.3	223	**106**	41.1	1058	**570**	299
44.6	**7**	-13.9	135	**57**	13.9	225	**107**	41.7	1076	**580**	304
46.4	**8**	-13.3	136	**58**	14.4	226	**108**	42.2	1094	**590**	310
48.2	**9**	-12.8	138	**59**	15.0	228	**109**	42.8	1112	**600**	316
50.0	**10**	-12.2	140	**60**	15.6	230	**110**	43.3	1130	**610**	321
51.8	**11**	-11.7	142	**61**	16.1	248	**120**	48.9	1148	**620**	327
53.6	**12**	-11.1	144	**62**	16.7	266	**130**	54.4	1166	**630**	332
55.4	**13**	-10.6	145	**63**	17.2	284	**140**	60.0	1184	**640**	338
57.2	**14**	-10.0	147	**64**	17.8	302	**150**	65.6	1202	**650**	343
59.0	**15**	- 9.44	149	**65**	18.3	320	**160**	71.1	1220	**660**	349
60.8	**16**	- 8.89	151	**66**	18.9	338	**170**	76.7	1238	**670**	354
62.6	**17**	- 8.33	153	**67**	19.4	356	**180**	82.2	1256	**680**	360
64.4	**18**	- 7.78	154	**68**	20.0	374	**190**	87.8	1274	**690**	366
66.2	**19**	- 7.22	156	**69**	20.6	392	**200**	93.3	1292	**700**	371
68.0	**20**	- 6.67	158	**70**	21.1	410	**210**	98.9	1310	**710**	377
69.8	**21**	- 6.11	160	**71**	21.7	428	**220**	104	1328	**220**	382
71.6	**22**	- 5.56	162	**72**	22.2	446	**230**	110	1346	**730**	388
73.4	**23**	- 5.00	163	**73**	22.8	464	**240**	116	1364	**740**	393
75.2	**24**	- 4.44	165	**74**	23.3	482	**250**	121	1382	**750**	399
77.0	**25**	- 3.89	167	**75**	23.9	500	**260**	127	1400	**760**	404
78.8	**26**	- 3.33	169	**76**	24.4	518	**270**	132	1418	**770**	410
80.6	**27**	- 2.78	171	**77**	25.0	536	**280**	138	1436	**780**	416
82.4	**28**	- 2.22	172	**78**	25.6	554	**290**	143	1454	**790**	421
84.2	**29**	- 1.67	174	**79**	26.1	572	**300**	149	1472	**800**	427
86.0	**30**	- 1.11	176	**80**	26.7	590	**310**	154	1490	**810**	432
87.8	**31**	- 0.56	178	**81**	27.2	608	**320**	160	1508	**820**	438
89.6	**32**	0	180	**82**	27.8	626	**330**	166	1526	**830**	443
91.4	**33**	0.56	181	**83**	28.3	644	**340**	171	1544	**840**	449
93.2	**34**	1.11	183	**84**	28.9	662	**350**	177	1562	**850**	454
95.0	**35**	1.67	185	**85**	29.4	680	**360**	182	1580	**860**	460
96.8	**36**	2.22	187	**86**	30.0	698	**370**	188	1598	**870**	466
98.6	**37**	2.78	189	**87**	30.6	716	**380**	193	1616	**880**	471
100.4	**38**	3.33	190	**88**	31.1	734	**390**	199	1634	**890**	477
102.2	**39**	3.89	192	**89**	31.7	752	**400**	204	1652	**900**	482

DEPTH CONVERSION-FEET TO METERS

Feet	0	1	2	3	4	5	6	7	8	9
0	0.0	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7
10.	3.0	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5	5.8
20.	6.1	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.8
30.	9.1	9.4	9.8	10.1	10.4	10.7	11.0	11.3	11.6	11.9
40.	12.2	12.5	12.8	13.1	13.4	13.7	14.0	14.3	14.6	14.9
50.	15.2	15.5	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.0
60.	18.3	18.6	18.9	19.2	19.5	19.8	20.1	20.4	20.7	21.0
70.	21.3	21.6	21.9	22.3	22.6	22.9	23.2	23.5	23.8	24.1
80.	24.4	24.7	25.0	25.3	25.6	25.9	26.2	26.5	26.8	27.1
90.	27.4	27.7	28.0	28.3	28.7	29.0	29.3	29.6	29.9	30.2
100	30.5	30.8	31.1	31.4	31.7	32.0	32.3	32.6	32.9	33.2
110	33.5	33.8	34.1	34.4	34.7	35.1	35.4	35.7	36.0	36.3
120	36.6	36.9	37.2	37,5	37.8	38.1	38.4	38.7	39.0	39.3
130	39.6	39.9	40.2	40.5	40.8	41.1	41.5	41.8	42.1	42.4
140	42.7	43.0	43.3	43.6	43.9	44.2	44.5	44.8	45.1	45.4
150	45.7	46.0	46.3	46.6	46.9	47.2	47.5	47.9	48.2	48.5
160	48.8	49.1	49.4	49.7	50.0	50.3	50.6	50.9	51.2	51.5
170	51.8	52.1	52.4	52.7	53.0	53.3	53.6	53.9	54.3	54.6
180	54.9	55.2	55.5	55.8	56.1	56.4	56.7	57.0	57.3	57.6
190	57.9	58.2	58.5	58.8	59.1	59.4	59.7	60.0	60.4	60.7
200	61.0	61.3	61.6	61.9	62.2	62.5	62.8	63.1	63.4	63.7
210	64.0	64.3	64.6	64.9	65.2	65.5	65.8	66.1	66.4	66.8
220	67.1	67.4	67.7	68,0	68.3	68.6	68.9	69.2	69.5	69.8
230	70.1	70.4	70.7	71.0	71.3	71.6	71.9	72.2	72.5	72.8
240	73.2	73.5	73.8	74.1	74.4	74.7	75.0	75.3	75.6	75.9
250	76.2	76.5	76.8	77.1	77.4	77.7	78.0	78.3	78.6	78.9
260	79.2	79.6	79.9	80.2	80.5	80.8	81.1	81.4	81.7	82.0
270	82.3	82.6	82.9	83.2	83.5	83.8	84.1	84.4	84.7	85.0
280	85.3	85.6	86.0	86.3	86.6	86.9	87.2	87.5	87.8	88.1
290	88.4	88.7	89.0	89.3	89.6	89.9	90.2	90.5	90.8	91.1

Feet	00	10	20	30	40	50	60	70	80	90
300	91.4	94.5	97.5	100.6	103.6	106.7	109.7	112.8	115.8	118.9
400	121.9	125.0	128.0	131.1	134.1	137.2	140.2	143.3	146.3	149.4
500	152.4	155.4	158.5	161.5	164.6	167.6	170.7	173.7	176.8	179.8
600	182.9	185.9	189.0	192.0	195.1	198.1	201.2	204.2	207.3	210.3
700	213.4	216.4	219.5	222.5	225.6	228.6	231.6	234.7	237.7	240.8
800	243.8	246.9	249.9	253.0	256.0	259.1	262.1	265.2	268.2	271.3
900	274.3	277.4	280.4	283.5	286.5	289.6	292.6	295.7	298.7	301.8

Feet	000	100	200	300	400	500	600	700	800	900
1,000 . . .	305	335	366	396	427	457	488	518	549	579
2,000 . . .	610	640	671	701	732	762	792	823	853	884
3,000 . . .	914	945	975	1,006	1,036	1,067	1,097	1,128	1,158	1,189
4,000 . . .	1,219	1,250	1,280	1,311	1,341	1,372	1,402	1,433	1,463	1,494
5,000 . . .	1,524	1,554	1,585	1,615	1,646	1,676	1,707	1,737	1,768	1,798
6,000 . . .	1,829	1,859	1,890	1,920	1,951	1,981	2,012	2,042	2,073	2,103
7,000 . . .	2,134	2,164	2,195	2,225	2,256	2,286	2,316	2,347	2,377	2,408
8,000 . . .	2,438	2,469	2,499	2,530	2,560	2,591	2,621	2,652	2,682	2,713
9,000 . . .	2,743	2,774	2,804	2,835	2,865	2,896	2,926	2,957	2,987	3,018

APPENDIX J

JULIAN DATE CALENDAR

Table of Contents

JULIAN DATE CALENDAR

(PERPETUAL)

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	
4	004	035	063	094	124	155	185	216	247	277	308	338	
5	005	036	064	095	125	156	186	217	248	278	309	339	
6	006	037	065	096	126	157	187	218	249	279	310	340	
7	007	038	066	097	127	158	188	219	250	280	311	341	
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029		088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

FOR LEAP YEAR USE REVERSE SIDE

JULIAN DATE CALENDAR

FOR LEAP YEARS ONLY

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	061	092	122	153	183	214	245	275	306	336	1
2	002	033	062	093	123	154	184	215	246	276	307	337	2
3	003	034	063	094	124	155	185	216	247	277	308	338	3
4	004	035	064	095	125	156	186	217	248	278	309	339	4
5	005	036	065	096	126	157	187	218	249	279	310	340	5
6	006	037	066	097	127	158	188	219	250	280	311	341	6
7	007	038	067	098	128	159	189	220	251	281	312	342	7
8	008	039	068	099	129	160	190	221	252	282	313	343	8
9	009	040	069	100	130	161	191	222	253	283	314	344	9
10	010	041	070	101	131	162	192	223	254	284	315	345	10
11	011	042	071	102	132	163	193	224	255	285	316	346	11
12	012	043	072	103	133	164	194	225	256	286	317	347	12
13	013	044	073	104	134	165	195	226	257	287	318	348	13
14	014	045	074	105	135	166	196	227	258	288	319	349	14
15	015	046	075	106	136	167	197	228	259	289	320	350	15
16	016	047	076	107	137	168	198	229	260	290	321	351	16
17	017	048	077	108	138	169	199	230	261	291	322	352	17
18	018	049	078	109	139	170	200	231	262	292	323	353	18
19	019	050	079	110	140	171	201	232	263	293	324	354	19
20	020	051	080	111	141	172	202	233	264	294	325	355	20
21	021	052	081	112	142	173	203	234	265	295	326	356	21
22	022	053	082	113	143	174	204	235	266	296	327	357	22
23	023	054	083	114	144	175	205	236	267	297	328	358	23
24	024	055	084	115	145	176	206	237	268	298	329	359	24
25	025	056	085	116	146	177	207	238	269	299	330	360	25
26	026	057	086	117	147	178	208	239	270	300	331	361	26
27	027	058	087	118	148	179	209	240	271	301	332	362	27
28	028	059	088	119	149	180	210	241	272	302	333	363	28
29	029	060	089	120	150	181	211	242	273	303	334	364	29
30	030		090	121	151	182	212	243	274	304	335	365	30
31	031		091		152		213	244		305		366	31

(USE IN 1964, 1968, 1972, etc.)

GPO 1964 O—722-685